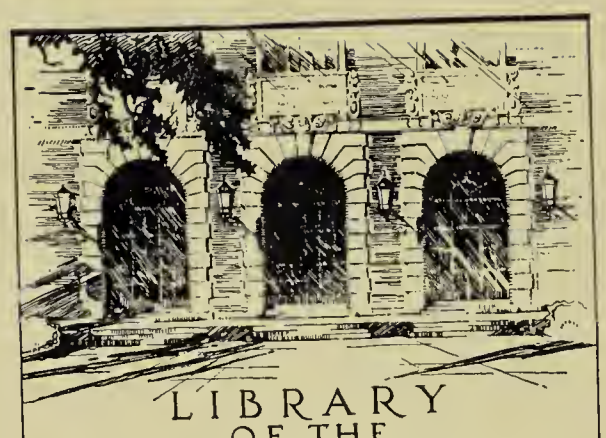

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Sagebrush CONTROL on Rangelands

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Washington, D.C. February 1965

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CONTENTS

	Page
Introduction	1
Where to control sagebrush	4
When to control sagebrush	8
Choosing a method of sagebrush control	10
Methods for sagebrush control	11
Planned burning	12
Spraying with herbicides	16
Plowing or disking	19
Anchor chaining	25
Cutting, beating, or shredding	27
Harrowing	29
Other methods	31
Regrassing after sagebrush control	34
Management of ranges after sagebrush control	36
Common and scientific names of plant species mentioned	39

Much of the material in this handbook, in an earlier form, was in Farmers' Bulletin No. 2072, Controlling Sagebrush on Range Lands, issued October 1954.

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SAGEBRUSH CONTROL ON RANGELANDS

By Joseph F. Pechanec, Director, A. Perry Plummer, Joseph H. Robertson,[1] and A. C. Hull, Jr.,[1] Range Conservationists,
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INTRODUCTION

Sagebrush control brings about major increases in grass production on millions of acres of western range. Getting rid of competing sagebrush and restoring a good stand of forage plants through natural or artificial seeding enables ranges to supply forage for more sheep and cattle, and is helpful in improving watersheds. In effect, new range is created on large areas, making possible a superior plant cover on adjoining ranges by better grazing management.

Innumerable examples have demonstrated that sagebrush eradication can more than repay its cost on many ranges in the West; double to 25 times greater grazing capacities have been obtained.

There are approximately 96 million acres of western range in the sagebrush type. On a large part of this rangeland, sagebrush is overly dense and must be reduced before increased forage yields can be obtained. This overly dense sagebrush is largely the result of overgrazing, together with drought. Sagebrush control is recommended primarily for ranges used by livestock in the spring, fall, and summer but not for those grazed chiefly in the winter. Here sagebrush, especially black sagebrush,[2] is often a desirable forage.

Likewise, control on ranges used by big game in the winter is not advocated where sagebrush is an important source of browse. A balanced mixture of broad-leaved herbs, grasses, and shrubs is considered desirable for most wildlife of these sagebrush ranges.

In tall, dense stands sagebrush is definitely undesirable (fig. 1, *A*). It is relatively unpalatable to sheep and cattle, and it uses moisture and nutrients that should be producing good forage (figs. 1, *B;* 2).

Sagebrush prevents grazing of grasses hidden under its woody stems and crown. It hampers movement of livestock, especially sheep. The brush snags wool from fleeces. It causes lambs and calves to stray and become lost, and heavy brush makes conditions ideal for predators such as coyotes. As a result of the increasing preponderance of sagebrush over valuable herbs and grasses, western ranges now carry far fewer livestock than they should.

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[1] The authors were all staff members of the Intermountain Station when the original manuscript was prepared. Mr. Robertson is now Chairman, Department of Plant Science, University of Nevada; Mr. Hull is with the Agricultural Research Service of the USDA.

[2] Scientific names of all plant species mentioned are given at the end of this handbook.

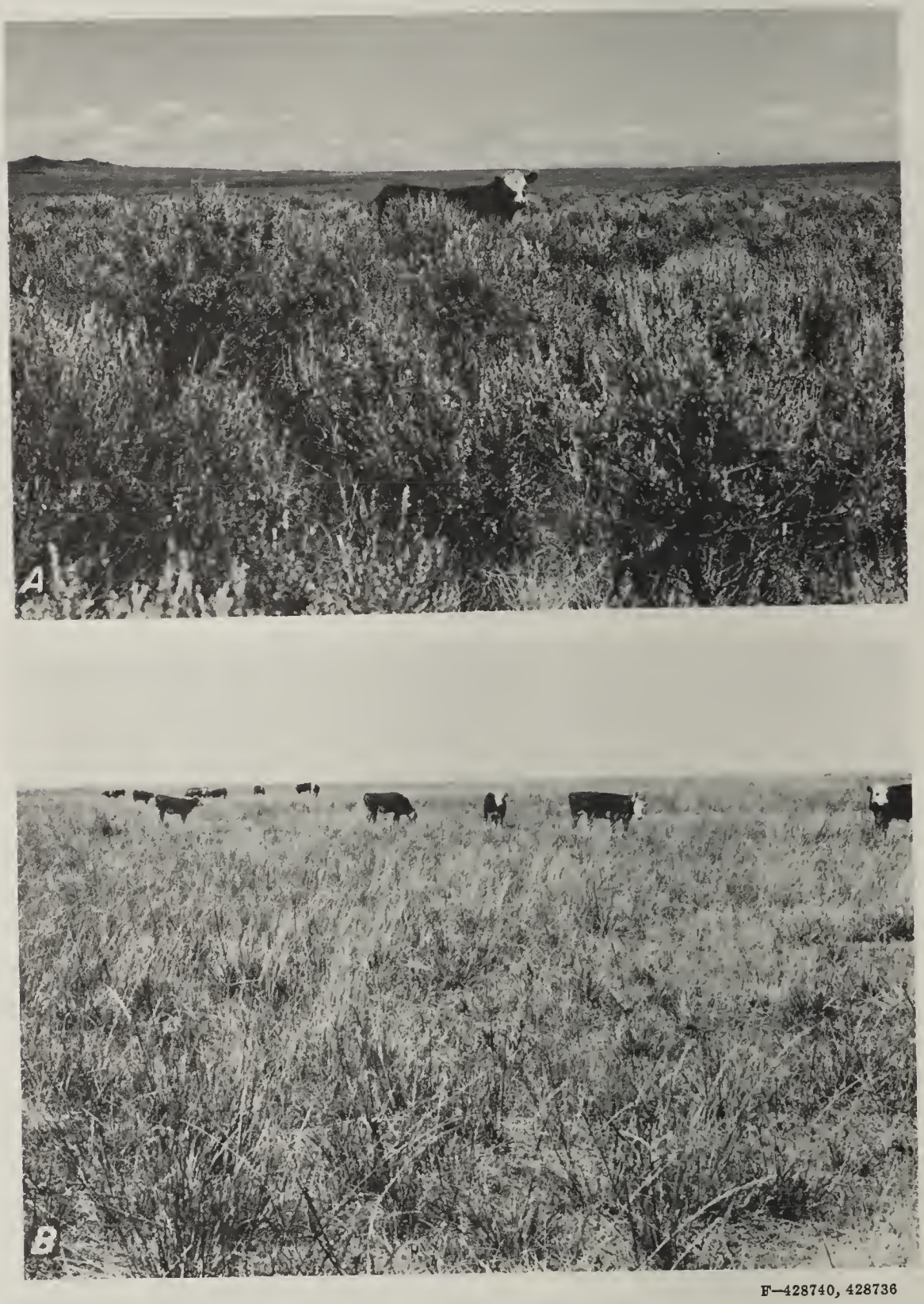

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FIGURE 1.—Dense stands of big sagebrush must be reduced before a range can be improved. *A*, Heavy stands of sagebrush such as this cover up the grass, hinder livestock movement, cause wool pulling and lamb straying, and use moisture needed to produce good grasses. *B*, Where dense stands of sagebrush have a fair understory of good native grasses, killing the sagebrush by burning, spraying with herbicides, or using some mechanical method will release the grasses from competition for moisture. With good grazing management, the grass can then increase and produce a good stand. Planned burning 3 years before this photo was taken has doubled the grazing capacity.

F—431209

FIGURE 2.—Where there is only a scattered understory of grass, the range must be seeded following sagebrush removal. This area supported a dense stand of sagebrush, like that shown in figure 1, but had no grass understory. The sagebrush was burned and the area drilled to crested wheatgrass. Three years later it could carry 15 times as many cattle as it could before treatment.

Without removal of sagebrush only slight improvement in forage yield can be expected on many ranges even after good grazing management has been practiced for 15 to 30 years. Where there is little or no understory of herbs and grasses, it may take much longer. Seeding should not be attempted until most of the sagebrush has been eliminated. Young grass seedlings cannot compete successfully for soil moisture with established sagebrush plants.

There are many shrubby species of sagebrush, all of which are often called just "sagebrush." Big sagebrush is by far the most common. Associated species are silver sagebrush, threetip sagebrush, low sagebrush, and black sagebrush. Black sagebrush is an excellent browse on winter range, but on spring-fall and summer ranges it may not be considered valuable. These associated species may be locally more abundant than big sagebrush, and methods of control may need to be altered to fit them. This publicatiton includes the best available information on methods that could be used for these species, where the methods differ from those recommended for big sagebrush. Methods for the control of sand sagebrush, a Southern Great Plains shrub, are described in other U.S. Department of Agriculture publications, which may be obtained by writing to the Southern Great Plains Field Station, Woodward, Okla.

In the past 30 years sagebrush has been controlled successfully on 5 to 6 million acres. More than half this acreage has been treated during the past 5 years. It is evident that the practice is gaining momen-

tum and will be applied to many more millions of acres in the West.

Most of the completed control work has been strikingly successful; some has not. Research and experience through these successes and failures throughout the West have shown that in planning for sagebrush control, the following items should be considered: (1) Where, (2) when, (3) how, (4) grazing management afterward, and (5) the need for regrassing afterward. The purpose of this bulletin is to make information on these items available for use by ranchers, public land administrators, and other land managers. By applying this information, they can eradicate sagebrush on large tracts more quickly and efficiently.

WHERE TO CONTROL SAGEBRUSH

Two conditions of sagebrush range may warrant control work. In the first, a dense stand of sagebrush suppresses the understory of desirable forage plants and interferes with grazing by livestock (fig. 3, *A*). In the second condition, desirable understory is lacking or is so sparse that seeding will be necessary following eradication of sagebrush (fig. 3, *B*).

On sagebrush ranges in either condition the probable returns in the form of increased forage and meat production, improved livestock management, and reduced danger of erosion determine the areas where sagebrush should be removed. Certainly it is not desirable or necessary to remove sagebrush on all of the 96 million acres of the sagebrush type. The following guides will help to determine where sagebrush control should be undertaken:

1. *Where sagebrush stands are dense and tall.*—Such stands of sagebrush (fig. 4, *A*) usually indicate fertile, productive soils and favorable soil moisture. High yields of grass can be expected; costs of sagebrush control will be quickly repaid. On the other hand, ranges with short or scattered sagebrush (fig. 4, *B*) generally do not warrant the expense unless they fill an important place in the seasonal livestock operation or unless livestock management may be simplified. Scattered tall sagebrush likewise is reason for caution. Widely spaced or short mature sagebrush often indicates poor soil or low precipitation. Hence, it pays to make sure precipitation and soil fertility are adequate for good forage production before control is undertaken.

2. *Where sagebrush makes up more than one-half of the plant cover.*—Such sagebrush stands definitely reduce forage production and hinder livestock movement, and should be controlled. Since the increase in grazing capacity will be related to the amount of sagebrush removed, investments in control work will bring best returns where sagebrush is thickest.

3. *Where other undesirable plants are not important parts of the plant cover, or will be controlled.*—Other undesirable plants such as rabbitbrush, horsebrush, cheatgrass, or halogeton often make up more than one-tenth of the plant cover. Unless these plants are effectively killed at the same time as sagebrush, they may increase sharply and become even more troublesome than the sagebrush. If undesirable plants can be eradicated only at an increased cost, this makes the lands they occupy secondary choices for control work. Care must be taken

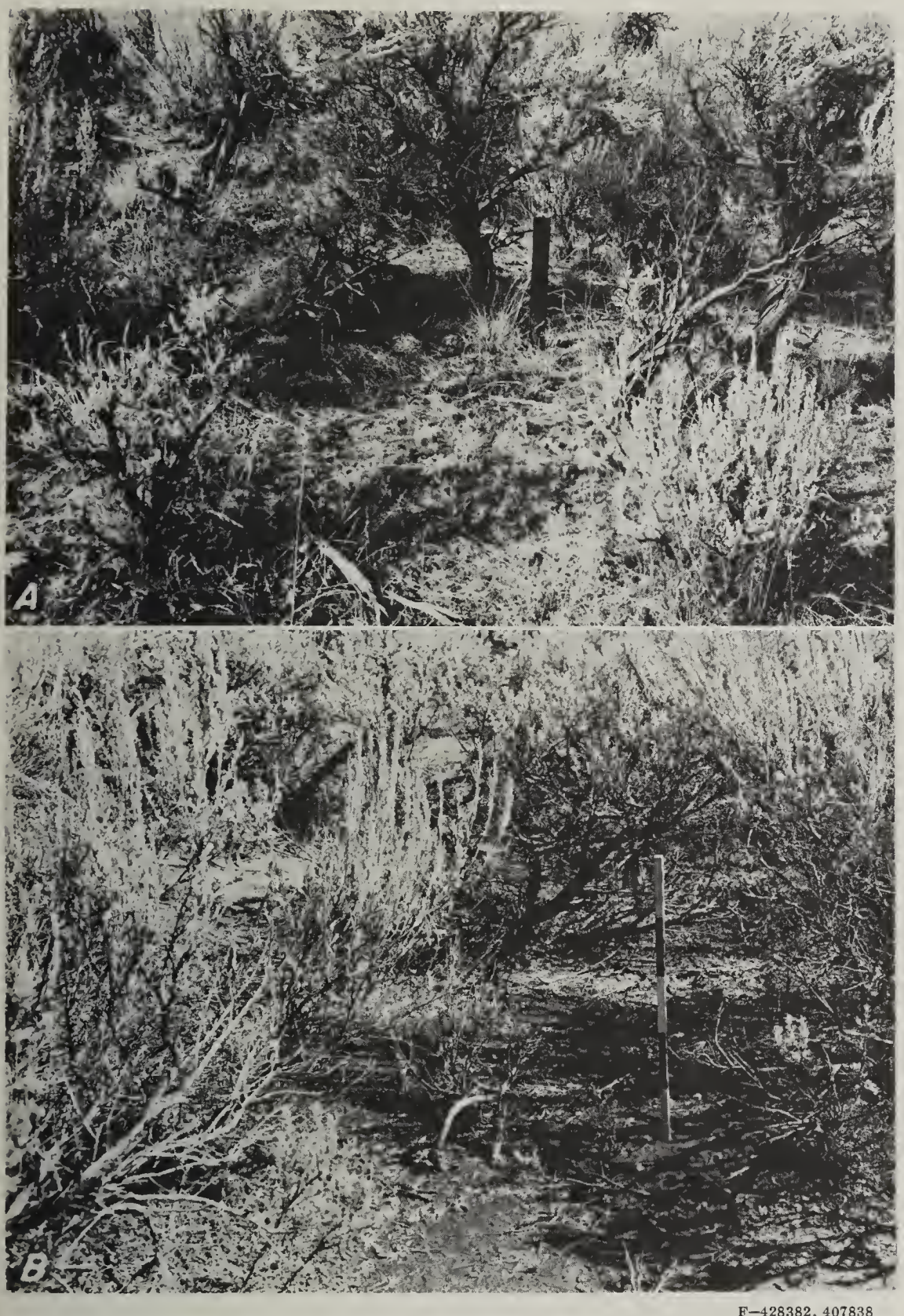

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FIGURE 3.—The amount of desirable forage species in the understory determines the need of seeding after sagebrush control. *A*, Desirable forage plants are suppressed. With removal of the competition by big sagebrush and with good grazing management the desirable plants would develop a satisfactory stand. *B*, The desirable forage plants are lacking or make up less than one-fifth of the plant cover. Here seeding is needed after sagebrush eradication to restore a grass cover, prevent reinvasion by sagebrush, and keep out other undesirable plants.

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FIGURE 4.—The density and volume of sagebrush growth is a good indication of the productivity of the site. *A*, Dense, tall stands of sagebrush such as this indicate sites that will produce an abundance of grass and easily repay the costs of sagebrush control. *B*, Scattered stands of short sagebrush usually indicate poor soil or low precipitation. Low forage production can be expected.

in sagebrush control work to avoid exchanging one problem for a more difficult one.

4. *Where good grazing management will be provided.*—Good grazing management will perpetuate increases in grazing capacity and continued freedom from sagebrush; poor management often kills grass plants and encourages the rapid return of sagebrush and other undesirables. Thus, to be sure that the expense of sagebrush control is repaid by increased forage yield, it is necessary to plan and carry out good grazing management as a part of the control program.

5. *Where seeding will be done promptly, if needed.*—Removing the sagebrush is of little value unless a satisfactory stand of grasses can be established by natural or artificial means. Seeding is usually needed where less than one-fifth of the total plant cover is composed of desirable plants. Many sagebrush ranges in this category, however, should not be cleared because their steepness of slope, rockiness, extremely poor soils, or arid conditions do not permit seeding by known methods. It is seldom desirable to remove sagebrush from more range than can be seeded within the first year afterward. If seeding is delayed, undesirable plants become established and reduce seeding success.

6. *Where soils do not erode easily.*—Where danger from wind or water erosion is high, the damage done as a result of sagebrush removal (fig. 5) may more than outweigh the expected improvement in grazing capacity unless a method of sagebrush control is used which

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FIGURE 5.—Sagebrush control should be applied with caution on light soils such as this, where wind erosion may be serious. Here an accidental burn has removed the protective sagebrush cover and allowed the sandy loam soil to blow and form dunes 3 feet high. On adjacent areas, up to 8 inches of soil has been removed by wind.

will not expose the soil dangerously. Practices such as spraying with herbicides, leaving debris on the soil surface, and removal of sagebrush in strips 200 to 500 feet wide along the contour or at right angles to the prevailing wind may be used as safeguards against water or wind erosion. After a good grass cover has been developed on these strips, the brush between should be removed. It should be remembered, however, that sagebrush plants, alone or in strips, are a seed source for potential reinvasion.

7. *Where sagebrush is not needed as forage for livestock and big game, or as upland bird habitat.*—Livestock, especially sheep, depend on sagebrush for browse during the winter and to a smaller extent during spring and fall on ranges where little other browse exists. On some late winter and early spring lambing ranges, the sagebrush also provides protection against blizzards and high, cold winds. On other ranges sagebrush is often a major ration for deer or antelope, especially in winter. On still other ranges, the sage grouse need sagebrush for food and cover. In these places control should not be undertaken except by methods that will only thin the stand, leaving enough sagebrush for the desired balance with grasses and other herbs.

WHEN TO CONTROL SAGEBRUSH

It is extremely important to choose the right season of the year for doing the work. This influences the percentage of sagebrush killed, the length of time that the range remains free of sagebrush, the survival of desirable grasses, the success of seeding, and the cost of the operation. The best season varies with the method used. Following are points to consider in regard to season for control:

1. *Control work should not be done during late fall, winter, and early spring after sagebrush seed starts to ripen and before it germinates.*—Operations during this period may effectively scatter and plant the sagebrush seed. Then the young sagebrush plants will come up before native forage plants have had a chance to thicken up, or at the same time as the seeded species (fig. 6). Studies in eastern Idaho have shown that young sagebrush that comes up the same spring as seeded grass may be initially suppressed but eventually becomes prominent in the stand. Consequently, to increase the chances of keeping the range relatively free of sagebrush for many years, it is desirable to avoid sagebrush control work from the time sagebrush seed starts to ripen until early spring when it has germinated. At the higher elevations at which big sagebrush grows, seed begins to ripen about the middle of September. At lower elevations, it may ripen as late as the last of November. Low sagebrush ripens seed about a month earlier than big sagebrush.

2. *Late summer and early fall is best for such methods as railing, chaining, harrowing, or rolling that uproot, crush, or break off the sagebrush.*—Sagebrush is usually brittle at these seasons and the soil is firm and dry. Under these conditions the kill is more complete than when the same methods are applied while sagebrush plants are willowy and tough.

3. *Late spring and early summer is best for such methods as plowing, disking, or root cutting that tear up or cut off the sagebrush below*

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FIGURE 6.—Thick stands of young big sagebrush such as this frequently result when control follows sagebrush seed ripening. Such stands will eventually dominate the range, and sagebrush control will again be necessary.

the ground level.—Although these methods will kill sagebrush at any time, the equipment works most efficiently and with less breakage when there is still some moisture in the ground. Among other advantages of early season control, moisture in the soil is conserved, the loose soil becomes firmer, and dead roots start the process of decay and conversion into soil organic matter. All of this stimulates better growth of grass following sagebrush control.

4. *Sagebrush is most susceptible to herbicides when it is growing rapidly.*—This closely corresponds to the date when bluegrasses are blooming and wheatgrasses are heading out. This and other points are explained in more detail in subsequent sections.

5. *The period when associated undesirable plants will also be killed is best for reducing overall competition.*—In much of the sagebrush range, associated undesirable plants such as cheatgrass and halogeton are present in substantial amounts. The best time for control of these may differ somewhat from that for sagebrush. For example, where cheatgrass forms a major part of the understory on sagebrush range, plowing should be completed before cheatgrass heads lose their green color. In this case, successful control work cannot be continued as late in the summer as if cheatgrass were absent. Where halogeton occurs, the appropriate period for plowing is after halogeton germinates in May and before it begins to mature in early September.

CHOOSING A METHOD OF SAGEBRUSH CONTROL

Many methods have been used to kill sagebrush. No one method is universally the best because sagebrush grows under widely different conditions and the sagebrush species differ. Suitability of methods varies with density, height, and age of the sagebrush stand, associated shrub species, amount of grass understory, topography, amount of rock on the area, type of soil and its susceptibility to erosion, facilities available for doing the work, size of the area to be treated, personal preference, and many other factors.

In choosing a method the following eight points are important:

1. *Use a method that kills most of the sagebrush.*—As a general rule, the more extensive the kill the better the method. When all sagebrush is killed, its return to the range is very slow because the seed source has been largely eliminated. However, control that leaves fewer than three sagebrush plants per 100 square feet is considered successful.

Exceptions to the general rule of killing as much of the sagebrush as possible occur where some sagebrush on the range has value for protection of or grazing use by domestic livestock or game, or in controlling wind erosion.

2. *Use a method that also kills associated undesirable species.*—Where the associated undesirables are so abundant as to become troublesome after sagebrush control, the method chosen should effectively control them also. Rabbitbrush or horsebrush not killed during sagebrush removal may increase so sharply as to prevent range improvement. Undesirable annuals present on the range such as cheatgrass and halogeton may become a serious barrier to the establishment of seeded grasses following sagebrush removal.

The definitions of undesirable and desirable plants must be flexible enough to allow for differences in species of plants on the range, season of use, class of livestock or game using the range, and other factors. Palatable perennial grasses, broad-leaved herbs, and shrubs such as bitterbrush and fourwing saltbush are generally accepted as desirable. Snowberry, black sagebrush, rubber rabbitbrush, and similar plants may be desirable or not, depending on season, type of use, and location.

3. *Use a method that does little damage to perennial grass remnants and other desirable plants if artificial seeding is not necessary, but if seeding is planned, use a method that kills most of the vegetation.*—On many ranges, enough desirable grasses remain to revegetate the area after sagebrush is removed. They may need only release from sagebrush competition. Seeding will be necessary if these remnants are destroyed; this nearly doubles the cost of treatment. There is also the uncertainty of getting stands from seeding. Therefore, where enough desirable plants are present to produce a good stand, they should be saved if possible.

If the aim is to improve forage quality through seeding, then particular attention should be paid to killing all plants including scattered desirable native plants that might compete with the seeded species. Past efforts to supplement seeded species by leaving desirable natives

have often resulted in poor seedbed preparation and in too much competition for successful establishment of seeded species.

4. *Use a method that leaves the land suitable for seeding, where seeding is necessary.*—In dense stands of sagebrush, such methods as spraying with herbicides or undercutting with root planes leave a barrier of dead woody material that makes it difficult to use grain drills. Additional operations are often necessary to break down or windrow this woody material before drilling.

5. *Use a method that is widely applicable.*—Where extensive tracts of range are to be treated, a method that is effective for killing young and old brush of various size, and on terrain varying in slope and stoniness, is much more useful than a method applicable only to restricted conditions.

6. *Use a method that utilizes readily available equipment adapted to other uses.*—Unless a large amount of sagebrush control work is to be done, purchase or construction of expensive equipment for this purpose alone may not be warranted. Often, however, the cost of recommended machinery is more than repaid by the more efficient eradication achieved. In many instances several individuals can purchase more costly machinery cooperatively, thereby reducing cost per acre and securing better sagebrush control. Contracting for sagebrush control by experienced operators with efficient equipment is often most economical for the landowner. This is particularly true for spraying operations.

7. *Use a method that will not increase erosion hazards.*—Some methods destroy all woody material and litter or cover it with soil to such an extent that wind and water erosion become serious hazards. Where soils are light and subject to drifting, or on slopes where water erosion is likely to occur, it is advisable to choose methods that will leave litter and plant material as a protective covering on the soil surface. In addition, a method that helps fill gullies and break down existing erosion patterns is desirable.

8. *Choose a method that is economical but also satisfies any of the seven points above that may apply to the area to be treated.*—Supervision and labor; transportation of men, equipment, and materials; interest on investment; initial costs of new equipment; and equipment operation, repair, and depreciation are all to be considered in calculating costs.

Costs vary with method. However, costs of applying a single method can vary more widely as a result of differences in experience, care in planning the job, and size of area treated.

Other values of rangeland must be examined when considering relative costs of different methods. For example, where watershed values are high and danger of erosion is present, it may be desirable to choose a method that leaves sagebrush litter on the soil surface, even though it costs more than some other adaptable method.

METHODS FOR SAGEBRUSH CONTROL

Both mechanical and nonmechanical methods have been used for the control of sagebrush. Most methods are mechanical. Some employ equipment such as the one-way disk (wheatland type), plow

and the offset disk, the anchor chain or the road ripper, all of which were built for other purposes; some employ equipment such as the brush cutter and beater that were built for other types of brush; and a few employ such equipment as the sagebrush rail, pipe harrow, and brushland plow that were designed specifically for sagebrush control. Some methods, including burning, flooding, and spraying with herbicides, are essentially nonmechanical. In recent years, spraying has become the most popular method for control of big sagebrush where seeding is not planned.

The most widely used methods for control of sagebrush on rangelands include burning, spraying, plowing or disking, chaining, cutting, and harrowing. A summary of their advantages and limitations is presented in table 1. These six methods are fully described and seven other methods are briefly considered in the following sections.

Planned Burning

Fire is one of the oldest, most widely adaptable, and least expensive methods for controlling sagebrush. It is also the most frequently misused. To insure range improvement it must be used skillfully. Proper precautions must be taken in selecting the area to be burned and the time of burning, and in controlling the fire; otherwise, range deterioration may easily result.

Simple, practical rules and guides on where, when, and how to burn and the grazing management to use after burning are presented in U.S. Department of Agriculture Farmers' Bulletin No. 1948, "Sagebrush Burning—Good and Bad." This bulletin will be helpful for anyone considering the use of fire for sagebrush control.

Thousands of acres of sagebrush range are burned over by accidental fires each year. Proper grazing management and seeding, where needed, may be effective methods for restoring a good forage cover to these areas.

The advantages and limitations of planned burning for sagebrush control are evaluated under the eight points previously listed under "Choosing a Method of Sagebrush Control," as follows:

Kill of sagebrush.—If burning is done properly, it gives a complete kill of young and old plants of big, low, and black sagebrush. Kill of threetip sagebrush is high, but a small percentage of the bushes may sprout from the base. Kill of silver sagebrush, which sprouts readily from the stem base and roots, is generally low.

Kill of associated undesirables.—Associated sprouting shrubs such as rabbitbrush, horsebrush, and snowberry are usually not killed by planned burning. Good kills of rubber rabbitbrush have been obtained from late summer burning, but this result is not consistent. Early or midsummer burning of cheatgrass will bring out a much reduced stand in the following spring; burning in the late summer or early fall is less effective.

Effect on desirable forage plants.—Damage to most desirable forage plants is fairly low. If burning is done after the principal perennial grasses mature seed, reduction in their vigor the following year is not likely to exceed 30 or 40 percent. On the other hand, Idaho fescue and bitterbrush (at some locations) have been severely damaged by

burning, regardless of the season. In eastern Idaho and parts of Utah, high percentages of bitterbrush have later sprouted from the stem base, particularly with light burning or on moist soil.

Ease of seeding afterward.—Where seeding is necessary afterward—except on rough and rocky areas or on slopes over 30 percent—seed is easily planted by use of a grain drill (fig. 7). Where land is too rocky or steep for drilling, the seed can be broadcast and covered by anchor chains or a heavy pipe harrow with fair success. Sagebrush ashes alone are not deep enough to adequately cover seed.

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FIGURE 7.—Planned burning on this area removed a dense stand of sagebrush that had little value for grazing. After burning, the more level, relatively rock-free areas were drilled without further preparation. Good stands of grasses resulted.

Adaptability to terrain and soil.—Excluding hazard of erosion, burning is widely applicable regardless of rockiness of soil, steepness of slope, or irregularity of terrain. It must be possible, however, to construct a wide, safe fireline.

Availability of equipment.—Bulldozers or graders for clearing firelines and torches for setting fires are readily available.

Effect on erosion hazard.—Debris and litter are largely consumed by the fire, and the soil is seriously exposed to erosion. Consequently, burning should not ordinarily be used on steep slopes or on soils that blow or wash readily.

Cost of control.—For tracts of 1,000 acres or more, the cost of sagebrush control by planned burning is $1 to $4 per acre, on the basis of 1962 wages and equipment rental rates. This includes up to $200 per mile for constructing firelines, the direct cost of burning the area, and the cost of leasing additional range for 1 or 2 years to permit protection of the burned area.

General adaptability of planned burning for sagebrush control.—Planned burning is most useful on fairly level tracts of 1,000 acres or more, either to permit the increase of perennial grasses and broad-leaved herbs already present or to prepare the land for seeding. Many

TABLE 1.—*Summary of limitations and advantages of the six most common methods of big sagebrush control*

Item	Method of control		
	Planned burning	Spraying with herbicides	Plowing or disking once over
Kill of big sagebrush	95 to 100 percent of all ages	50 to 99 percent of large old; slightly less of young.	70 to 99 percent of old; slightly less of young.
Kill of associated undesirable plants.	Not effective on sprouting shrubs and some annuals.	Good on rabbitbrush resprouted after fire.	Usually not effective on sprouting shrubs; good on cheatgrass.
Effect on desirable forage plants	Low kill of grass, 30 to 40 percent loss in vigor first year. Nonsprouting shrubs killed.	Grass not damaged; some broadleaved herbs and nonsprouting shrubs may be damaged.	Kills all except those that sprout or spread by rootstocks.
Ease of seeding after treatment	Easily done with drills; seed can be aerially broadcast and covered with anchor chain or pipe harrow; firm seedbed.	Standing dead brush may be barrier to drilling. Seed can be aerially broadcast and covered with anchor chain or pipe harrow.	Easily done with drills; seedbed may require packing.
Adaptability to terrain and soil	No limit except as imposed by fire danger and erosion hazard.	Virtually unlimited	Limited to little or no rock except with brushland plow.
Availability of equipment	Equipment generally available; brush rake useful; experience primary need.	Commercially available	Plows and disks commercially available; brushland plow is custom made.
Effect on erosion hazard	Exposes soil, destroys litter (unsuited to highly erosive areas).	Slight if any	Exposes soil to moderate degree.
Cost of control (1962)	$1 to $4 per acre on tracts of 1,000 acres or more.	$2 to $6.50 per acre	$4 to $7 per acre.

TABLE 1.—*Summary of limitations and advantages of the six most common methods of big sagebrush control*—Continued

Item	Method of control		
	Anchor chaining	Cutting, beating, or shredding	Harrowing
Kill of big sagebrush	60 to 80 percent of old rigid brush, 10 to 20 percent each additional time over; 10 to 40 percent of young flexible brush.	50 to 90 percent of large old; 30 to 60 percent of young flexible.	30 to 70 percent of old rigid; 10 to 30 percent of young flexible.
Kill of associated undesirable plants.	Not effective on sprouting perennials or on annuals.	Not effective on sprouting shrubs or herbaceous species.	Not effective on sprouting shrubs or annuals.
Effect on desirable forage plants	Nonsprouting shrubs are damaged; sprouters recover; little damage to herbaceous species.	Little damage to herbaceous plants; nonsprouting shrubs damaged.	10 to 20 percent of bunchgrasses uprooted; damage to bitterbrush slight.
Ease of seeding after treatment	Broadcast before second chaining, or drill after final chaining where feasible.	Broadcast before cutting or beating heavy brush; drill after treating light brush.	Seed broadcast ahead of harrow well covered; drilling difficult.
Adaptability to terrain and soil	Feasible on all soils and on slopes exceeding 30 percent. Breakage rare.	Limited to sites without protruding rocks.	Particularly suited to rocky ground and rough terrain.
Availability of equipment	Commercially available through coastal salvage companies, or new.	Commercially available	Not commercially available; can be built in machine shops.
Effect on erosion hazard	Erosion usually decreased when approximate contours followed.	Mulch left decreases hazard	Usually decreases hazard.
Cost of control (1962)	$0.75 to $2.50 per acre each time over.	$4 to $10 per acre	$4 to $7 per acre.

stands of sagebrush, however, can be burned only under conditions of extreme fire hazard. Under weather conditions that make burning relatively safe, such stands cannot be burned because they are too open and lack an understory of grasses to carry the fire. Where the erosion hazard is high or the dominant perennial grasses are subject to serious damage, burning should not be used.

Although burning sounds simple, it is one of the most difficult and dangerous methods. To use fire properly and safely, it is necessary to have experience in the behavior of fire, the conditions suitable for ignition, and methods of fire control. Moreover, ample equipment and men with some experience must be on hand to insure keeping the fire under control. All burning operations should comply strictly with State and county laws regarding burning. *Fire is a dangerous tool for the inexperienced person to handle*, but is a valuable one when intelligently used.

Spraying With Herbicides

Herbicides should be applied only when needed, and should be handled with care. Follow the directions and heed all precautions on the container label. If herbicides are handled or applied improperly, or if unused portions are disposed of improperly, they may be injurious to humans, domestic animals, desirable plants, fish, and wildlife, and may contaminate water supplies.

Both experimental and practical spraying with 2,4–D and 2,4,5–T have produced good kills of big, low, black, and silver sagebrush. Kills of 50 to 99 percent of big sagebrush plants have been reported from most Western States.

The recommended procedure varies somewhat from place to place and with different species of sagebrush. In general, results show that spraying should be done when sagebrush is actively growing and there is still ample soil moisture for growth. Usually this is when native understory bluegrasses are flowering and the wheatgrasses are just heading out. The effective spraying season begins when small bluegrasses are heading out and ends when they are losing green color rapidly and the surface foot of soil is dry.

One or two pounds (acid equivalent rates) of ester formulations of 2,4–D or one pound of 2,4,5–T in 5 to 10 gallons of water or 3 to 5 gallons of diesel oil per acre are the rates of herbicide and carrier ordinarily used. Early in the season 1 pound of 2,4,5–T is equal to 2 pounds of 2,4–D on big sagebrush. Later in the season both are equally effective. At present prices, 2,4–D gives cheaper control of big sagebrush than 2,4,5–T. If water is used as the carrier, a wetting agent at 0.1 to 0.5 percent by volume is needed to improve the wetting properties. An oil-water emulsion at 1 : 5 to 1 : 10 ratio can also be used. Low-volatile esters are recommended because they are less dangerous to use near valuable timber and cultivated crops.

Since the chemicals do not appear to be translocated radially in woody portions of sagebrush branches and stems, degree of kill depends largely upon how well the spray solution covers the herbage. The more dense the brush, the greater the volume of spray material needed. Application of the spray solution is by ground rigs, airplanes, or helicopters (fig. 8).

F–504845, 465823, 465822

FIGURE 8.—Herbicides may be sprayed by air or ground applicators. *A*, Helicopter spraying in Utah. *B*, Airplane spraying herbicide on sagebrush in Wyoming. *C*, Ground spray outfit mounted on a crawler tractor. This outfit covers a 30-foot swath and travels 3 miles per hour.

The advantages and limitations of spraying with herbicides for sagebrush control are as follows:

Kill of sagebrush.—While results are variable, satisfactory kills of big, low, black, and silver sagebrush of all age classes have been reported. In stands of mixed ages the younger plants are least injured. Silver sagebrush is best killed near the end of the effective season for spraying big sagebrush.

Kill of associated undesirables.—Rabbitbrush and broom snakeweed can be killed along with sagebrush by increasing the 2,4–D ester to 3 pounds per acre and spraying towards the last of the season that is effective for killing big sagebrush, and when soil moisture is still adequate for growth of rabbitbrush. This is when new twig growth on rabbitbrush exceeds 3 inches in length and when wheatgrasses are heading out. Earlier application would kill the tops only and encourage sprouting. One to two pounds per acre is sufficient on rabbitbrush sprouts the year following burning. This spray kills prickly-pear on some areas but not on others; it does not damage spineless horsebrush.

Effect on desirable forage plants.—Perennial grasses are not damaged by spraying with 2,4–D although grass seedlings are damaged with heavy rates. Damage to broad-leaved herbs varies from light to heavy. Important forage species that are damaged moderately to severely include arrowleaf balsamroot, milkvetch, oneflower helianthella, bluebell, and tailcup lupine. Important forage plants unharmed or slightly damaged are tapertip hawksbeard, penstemon, geranium, and groundsel. Spraying is not recommended where many desirable broad-leaved herbs are present that will be damaged by 2,4–D.

Associated desirable shrubs on arid sites such as shadscale, winterfat, and Gardner saltbush are readily killed by 2,4–D.

On mountains and foothills, aerial portions of most shrubs are killed, but most of them resprout vigorously. Serviceberry and chokecherry are among the most susceptible shrubs. Damage to bitterbrush from spraying is light to moderate. Damage to bitterbrush growing in sagebrush is reduced by spraying 2,4–D at low rates early in the effective season for spraying big sagebrush. Douglas-fir is little damaged, whereas lodgepole pine shows more damage. 2,4–D kills aspen tops, but there is abundant sprouting following spraying.

Ease of seeding afterward.—Where sagebrush is short or stands are open, drilling has been successful after spraying. Ordinarily, dense tall stands of big sagebrush must be knocked down by an anchor chain, rail, or harrow before drilling. The newly developed, rugged Rangeland drill will effectively plant following spraying on all sagebrush areas except those having exceptionally large and dense brush. Information regarding the purchase of this drill may be obtained from the U.S. Forest Service Equipment Development and Testing Center, Arcadia, Calif.

Adaptability to terrain and soil.—Spraying is widely applicable. Use of ground rigs is limited to relatively level areas, but airplanes and helicopters permit application of spray to nearly all sites. There are rather clear indications that big sagebrush control by spraying may be more effective in swales or on level bottom lands than on ex-

posed slopes or ridgetops, because of variations of soil moisture. Care should be taken to avoid letting the spray reach valuable timber or cultivated crops near the areas being treated, especially with high-volatile esters.

Availability of equipment.—Many companies specialize in spraying with ground rigs, airplanes, or helicopters. Several types of equipment for ground application are readily available. Ground sprayers usually need reinforcement of the booms for use on rough and rocky ground.

Effect on erosion hazard.—The erosion hazard usually is not increased by spraying. The dead standing brush, undisturbed litter cover, and undisturbed soil and grasses normally check erosion. Care should be taken in spraying streambanks and slopes where erosion may increase as the result of the loss of plant cover.

Cost of control.—Costs of spraying are about the same as for plowing or disking. Based on present prices of 2,4–D and 2,4,5–T or mixtures of the two, and the present cost of the carrier and of application by airplane, the total cost of spraying sagebrush from aircraft ranges from $2.50 to $6 per acre. Application by ground rigs is likely to cost about $2 more.

General adaptability of spraying for sagebrush control.—Present indications are that spraying is most useful either on ranges that have a good understory of native grass to thicken up and replace sagebrush, or on seeded areas that have been invaded by sagebrush (fig. 9). It may also be useful for killing sagebrush preparatory to seeding on areas where sagebrush is short or sparse. Spraying is sometimes used to prepare perimeters of areas for burning. Sometimes spraying in May or June can be followed by burning the next March or April when the fire hazard is low. The interior may then be burned more safely in July or August.

Widespread spraying of sagebrush should be undertaken with caution. Numerous large-scale spraying jobs have been failures or poor successes. Lack of knowledge about effects of herbicides on the associated desirable broad-leaved forage plants and shrubs, and on animal life depending upon this vegetation, gives further reason for caution. Since new information on chemicals and methods is constantly becoming available, anyone considering this method should get the latest information from county agricultural agents, State agricultural colleges, or representatives of Federal agencies acquainted with range-improvement work. Most States have laws governing the use of herbicides for plant control. Consequently, anyone planning to use herbicides for sagebrush control should check his county and State laws.

Plowing or Disking

Despite the improvement in herbicides, plowing and disking continue to be the most valuable methods of sagebrush clearing where seeding is to be done—especially by drilling. The three implements used widely are the brushland plow, the one-way disk plow (wheatland type), and the heavy offset disk (figs. 10, 11, and 12).

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FIGURE 9.—*A*, Sagebrush range with a good grass understory just before it was sprayed with 2,4–D in 1960. *B*, Two years later grass production had increased severalfold as the result of spraying and suspension of grazing.

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FIGURE 10.—The brushland plow is especially useful for the control of big sagebrush preparatory to seeding where some rock is present. The pair of disks on the left side is rising over a rock. Sturdy construction and the separate mounting of each pair of disks permit this implement to be used on moderately rocky land without excessive breakage.

F—425026

FIGURE 11.—One-way disk plow being used on rock-free ground to eradicate big sagebrush in preparation for seeding.

F—466074

FIGURE. 12.—Heavy offset disks effectively kill sagebrush and prepare a good but loose seedbed. They cut well in hard-packed soils. They should be used only on relatively rock-free areas.

A 40- to 45-horsepower tractor and a plow or disk with a 10-foot cutting width form a convenient unit for killing sagebrush under most conditions. The plow or disk should weigh at least 300 pounds per foot of cutting width and be equipped with disks preferably 28 inches in diameter. However, implements with 24- and 26-inch disks have done good jobs. Use of a tractor with 3 to 5 horsepower per foot of cutting width is ordinarily advisable, but the power requirement varies widely with soil conditions, amount of soil moved, density of brush, and topography.

The heavy offset disk, especially one weighing 500 pounds or more per foot of cutting width, requires more draft power than either the one-way or the brushland plow because, lacking adequate depth control, it usually moves more soil and moves it twice. This heavy disk is practically the only implement that is effective in killing sagebrush on heavy, compact, crusted soils, such as those in the dry-lake bottoms of northeastern California. Such lands are much more easily plowed when moisture is present near the soil surface than at other times. Crawler-type tractors are the most satisfactory, but wheel tractors of equivalent power—especially if their traction is augmented by wheel weights, large tires, or solution in the tires—may be substituted where the ground is fairly level and the soil is firm. Though smaller tractors can be used on level or moderately sloping ground, the greater

speed and power of larger tractors usually more than offset their higher operation costs.

In order to save power, the plow or disk should cut to the least depth that will provide an adequate kill. Three to four inches deep is usually sufficient. Allowing disks to cut too deeply should be avoided on heavy land where a clay subsoil may be turned up and cause surface crusting, or on sites where a shallow soil lies over coarse sand or gravel. Moreover, deep plowing or disking loosens the seedbed too much. Grass seedlings root themselves better in firm seedbeds. Deep plowing followed by packing may be advisable where mineral soil can be brought up to cover fluffy, organic surface soil sometimes found in valley bottoms where sagebrush has replaced native meadows.

All plows and disks cut better, require less power, and give better brush kills in the late spring and early summer, or at other times when the ground contains moisture than when it is dry. Spring plowing also allows loose soils to settle to some extent and part of the plant material to decay before seeding is done later in the year.

Since the one-way disk plow, offset disk, and brushland plow are in general similar, their advantages and limitations will be described together.

Kill of sagebrush.—Plowing or disking, correctly done, will kill 70 to 99 percent of all except silver sagebrush. The bigger the sagebrush and the softer the ground, the better the kill. This applies even to stands 8 to 10 feet in average height. Unless plowing is deeper than is recommended for ordinary work, thick stands of young plants and silver sagebrush will not be satisfactorily eradicated. If plows and disks are properly adjusted, one plowing effectively kills young and old sagebrush alike, except on heavy, compact, dry soil where these plows do not cut, and many of the younger plants are skipped. It may be necessary to plow such areas twice. Light-colored, heavy-textured soils, however, tend to puddle and crust when tilled excessively.

The brushland plow gives a slightly higher kill of brush than the one-way disk plow or ordinary offset disk. However, the heavy offset disk, weighing 500 pounds or more per foot of cutting width, often equals the brushland plow in brush control. Heavy disk plows now available also equal the brushland plow in effectiveness unless rocks prohibit their use.

Kill of associated undesirables.—Associated sprouting shrubs such as rabbitbrush are not killed unless the disks cut much deeper than the customary 3 to 4 inches. In some instances, fairly effective rabbitbrush control has resulted from plowing an area twice. This doubles the cost, but is usually justified where rabbitbrush covers small areas in extensive sagebrush stands. Cheatgrass and other undesirable annuals generally are effectively thinned if the work is done in the spring after seed germination but well before seed ripening; control will be ineffective if work is done after seed starts to ripen. Cheatgrass can also be satisfactorily controlled by plowing after fall germination, but this is usually too late for sagebrush control because its seed is ripe by then.

Effect on desirable forage plants.—Nearly all perennial plants except those that spread by rootstocks or sprout from roots, are killed by plowing or disking at a depth adequate for effective control of sage-

brush. These methods should be limited, therefore, to ranges that are to be seeded.

Ease of seeding afterward.—Grain drills can be used after plowing or disking, especially on rock-free or slightly rocky soils where the cover of big sagebrush was not extremely dense before the plowing. Considerable difficulty in drilling may be experienced where the brush was big and dense; here it may be necessary to broadcast the seed. There may also be some difficulty in controlling depth of drilling seed on areas plowed in summer and early fall because the soil may be rather loose. Compaction by heavy rollers when the soil is damp greatly improves such seedbeds. Efforts at compaction when the soil is perfectly dry not only fail but damage soil structure and encourage wind erosion. Spring plowing helps to overcome this difficulty.

Adaptability to terrain and soil.—Plowing or disking with conventional farm implements is limited to rock-free or slightly rocky sites on slopes of less than 20 percent. Otherwise breakage will be unduly high. The brushland plow permits treatment of more rocky sites without undue breakage. Plowing or disking effectively reduces the existing stand of sagebrush during any season of the year when weather and soil conditions permit the work.

Availability of equipment.—Heavy one-way offset disks equipped with large-sized disks are made by several companies and are readily available. The brushland plow was developed by the U.S. Forest Service, after the design of an Australian stump-jump plow, for brush control on rough, rocky lands. It is now available on a custom-made basis. Addresses of suppliers of this plow may be obtained from the Forest Service, U.S. Department of Agriculture, Washington, D.C., 20250.

Effect on erosion hazard.—Part of the debris may best be left on the surface to protect the soil. This and loose, absorbent soil ordinarily decrease the erosion hazard. In some situations, on the other hand, the hazard of wind or water erosion is high because of slope or lightness of soil; here the use of other methods should be considered.

Cost of control.—Usually the cost is moderate. One well-trained operator with a 40- to 45-horsepower crawler tractor and a 10-foot disk or plow can average 1½ to 2 acres per hour, with a minimum of 1 and a maximum of slightly more than 3 acres. Accomplishment is at its lowest where the sagebrush range is in tracts of 10 acres or less, or the terrain is rough with steep slopes. Maximum acreages per hour are possible on large tracts of 1,000 acres or more where the ground is only slightly rocky, practically level, and not gullied.

Costs are slightly different for the three implements and must include original purchase price, power required to pull the disks or plows, and costs of maintenance and depreciation. The purchase price of the heavier, noncommercial brushland plow is at least twice that of offset disks or one-way disk plows of equivalent cutting width. Extremely low breakage, maintenance, and depreciation largely offset the greater initial cost and difficulty of transportation. The greater adaptability of the brushland plow to rough and rocky rangelands sets it apart as the most widely useful machine for plowing rocky land. Maintenance and depreciation costs are much lower for the heavy-duty offset disk than for the one-way, if rocky land is treated.

Careful operation and frequent maintenance are important in keeping breakage of all implements at a minimum.

Average costs for plowing or disking under ordinary conditions, based on 1962 wages and rates for equipment rental, range from $4 to $7 per acre. Costs are generally least with the brushland and highest with the one-way disk plow because of differences in amounts of breakage and maintenance. Because it requires approximately one-third greater draft power, the offset disk costs more to operate than the one-way disk plow or the brushland plow. On large tracts, use of two or three implements pulled by a single 60- to 130-horsepower tractor can reduce plowing costs by one-fourth to one-third.

General adaptability of plowing or disking for sagebrush control.—Plowing is primarily useful on rock-free to slightly rocky ranges where seeding is to be done afterward. The heavy offset disk and one-way disk plow have proved effective in eradicating all types and ages of sagebrush, except silver sagebrush, on soils that are rock-free or have only a little rock. An extra heavy offset disk has proved the best implement for use on heavy, crusted soils. The brushland plow has proved effective not only on rock-free sagebrush lands but also where scattered large rocks are likely to cause breakage of one-way disk plows and offset disks.

In order to obtain satisfactory control of tenacious brush under difficult soil conditions, it is sometimes desirable to allow the ground to lie fallow for a year between plowings.

Anchor Chaining

Anchor chaining, a common method of controlling juniper and pinyon in the West, has proved to be a rapid, low-cost method for reducing competition of big sagebrush (fig. 13). It provides only

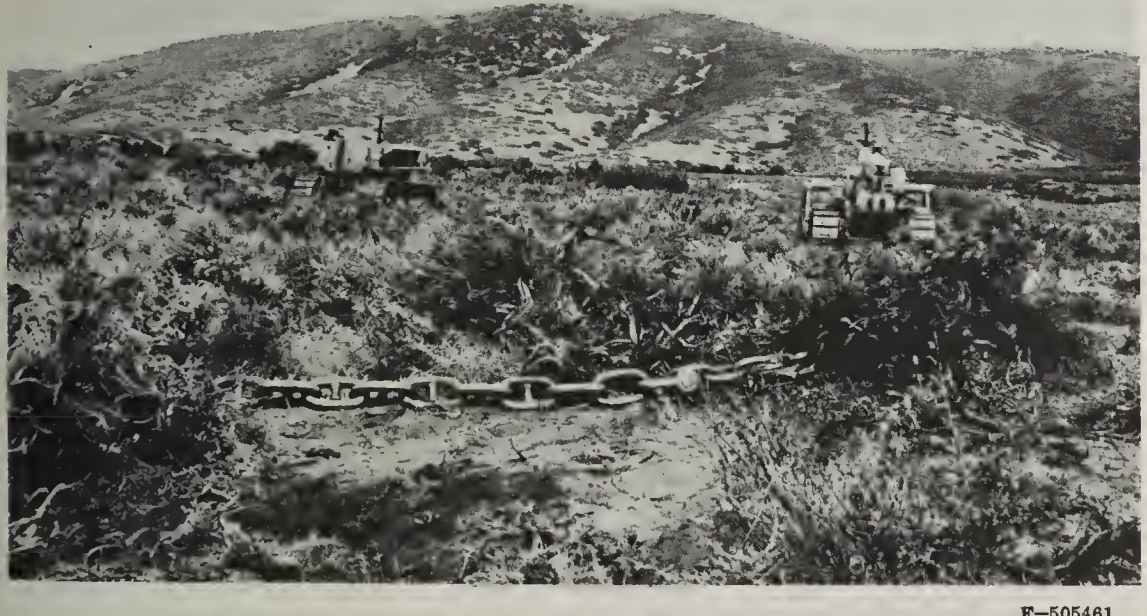

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FIGURE 13.—Heavy anchor chains looped between large tractors readily uproot or break off brittle sagebrush. However, for young flexible sagebrush two to three times over may be needed to remove satisfactory amounts of the brush.

partial control, but costs less than other methods. It is especially useful where a mere thinning of the brush stand is desired, and for the removal of juniper and pinyon trees as well.

Chains weighing from 25 to 90 pounds per link have been used. Chains with links heavier than 70 pounds eliminate more sagebrush than lighter chains. Twice over is usually desirable. The second chaining not only removes additional brush, but also facilitates seeding operations by covering seed broadcast between the two chainings or by breaking down the brush to ease subsequent drilling.

Two crawler tractors of at least 40 horsepower each, with a 200-foot heavy chain looped between them, can cover a swath about 150 feet wide. Up to 600-foot lengths of lighter chain, with links weighing 50 pounds or less, have been used successfully to thin and break down sagebrush and make more forage available. The lighter chains permit more rapid treatment, but heavy chains remove more brush.

Advantages and disadvantages of chaining follow:

Kill of sagebrush.—Up to 90 percent control of big sagebrush has been obtained from once-over treatment using heavy chains on even-aged, old, brittle brush, but 50 to 70 percent is more common. On younger, flexible stands of sagebrush, from 10 to 40 percent kills are accomplished with once-over chaining. Two or three times over generally are required to control more than 50 percent of flexible sagebrush; the second and third times over, in opposite directions, usually increase control 10 to 20 percent. Chaining generally is more effective on rocky ground than on rock-free ground.

Kill of associated undesirables.—Low kills result on woody species that sprout from the crown such as snowberry, horsebrush, broom snakeweed, and rabbitbrush. However, these shrubs are usually broken down enough to permit herbaceous perennials or seeded grasses to establish and gradually increase. Annuals increase markedly immediately after sagebrush competition is reduced, but within a 3- to 5-year period perennial herbs usually increase enough to largely suppress the annuals. Where desirable perennials are scarce, seeding of adapted perennials should be a part of the restoration operation in conjunction with chaining.

Effects on desirable forage plants.—Damage to the desirable herbaceous plants is negligible, but varies on desirable browse species. Damage to tall bitterbrush plants appears to be high the first year, but these shrubs recover rapidly and within 2 to 3 years usually are more vigorous and productive than before. Chaining can be highly destructive to tall-growing single-trunk cliffrose and curlleaf mountain mahogany. But bushy plants of these shrubs show little damage after a year's growth; in fact, they usually respond with greater growth and seed crops that compensate for the loss of the larger upright plants. True mountain mahogany, fourwing saltbush, and saskatoon serviceberry are knocked down but usually recover.

Ease of seeding afterward.—Broadcasting, by either airplane or mechanical broadcasters, is the most practical method of seeding in conjunction with chaining. Good stands usually result from broadcast seeding between two chainings. The second chaining, in the direction opposite to the first, is helpful in getting a desirable amount of seed coverage. Drilling is usually possible following twice-over with

a heavy chain. Where brush is exceptionally heavy, a third time over may be necessary to prepare for effective operation of a drill.

Adaptability of terrain and soil.—Chaining is adapted to wide variation in terrain, and is useful on areas too rocky and sloping for other mechanical methods. It has been found feasible on slopes exceeding 30 percent. Chaining that approximately follows the contour is preferable. One tractor often can work on a ridgetop and the other in the canyon bottom, so that the chain is pulled across the slope. Where the slope is steep and too long for this maneuver, a tractor with a bulldozer can cut out a trail for the uphill track.

Availability of equipment.—Anchor chains of various weights can be readily purchased from coastal salvage companies at much lower prices than new chains, which are available from steel companies.

Effect on erosion hazard.—Chaining usually decreases erosion, especially where treatment is at right angles to the prevailing drainage and gully patterns. Considerable brush and debris are usually dragged into the gullies; this checks erosion.

Cost of control.—On large areas, costs of $0.75 to $2.50 per acre are usual for once-over chaining where swaths 100 to 150 feet wide are possible. Twice-over treatment approximately doubles this amount. Actually, chaining is the least costly mechanical treatment for large areas.

General adaptability for sagebrush control.—Chaining is a satisfactory, low-cost method of removing old, mature, brittle stands of sagebrush from extensive areas. Adapted to a wide range of terrain conditions, chaining can be applied to areas where mechanical treatment previously has been considered uneconomical because of rocks and steep slopes. The method also is useful for knocking down and scattering dense brush killed by herbicides, and for covering seed broadcast into such areas. It is not an efficient method for controlling young, flexible sagebrush.

Cutting, Beating, or Shredding

In recent years the cutter, beater, or "shredder" type of implement has been widely used in sagebrush control. These machines cut and shred the woody and herbaceous top growth. They leave a coarse litter layer on the soil surface.

Cutters and beaters or "shredders" are mainly of two types. The type most widely used works like a rotary lawnmower. It consists of horizontal cutting blades fastened to the lower end of one or more vertical shafts (fig. 14). The second type of machine is a beater consisting of a rapidly revolving drum or shaft, mounted between two wheels. To the drum are attached flexible arms or flails of chain, cable, or metal bars that swing straight out from the rapidly revolving drum. Both machines are driven from the power takeoff on the tractor or by separate motor.

For killing sagebrush these implements are adjusted so that blades or flails just miss hummocks or projecting rocks. Occasional contact with the soil surface is unavoidable on uneven ground, but it should be kept to a minimum. The machines operate most efficiently and with the least maintenance and repair if the ground clearance averages 3 inches. Setting blades or flails too high results in a poor kill of

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FIGURE 14.—Brush cutters give a good kill of old, large plants of big sagebrush without injuring herbaceous plants. Small or low-growing sagebrush is little damaged.

small plants; setting too low results in high breakage costs. One trip over an area is ordinarily sufficient.

Advantages and limitations of the method are as follows:

Kill of sagebrush.—Cutting is effective in tall old stands of big sagebrush; kills of 90 percent or more of old brush are often obtained. Highest kills are on rock-free level ground. Young plants of big sagebrush are usually missed or little damaged by cutters and flails. Control of threetip, low, and black sagebrush is only partially satisfactory because of their low, spreading branches and the tendency of threetip sagebrush to sprout from the base. Kills of silver sagebrush are unsatisfactory because of strong sprouting from the stem base and roots.

Kill of associated undesirables.—Sprouting shrubs such as rabbitbrush and horsebrush and annual grasses such as cheatgrass are not controlled.

Effect on desirable forage plants.—Grasses and broad-leaved herbs growing beneath the sagebrush are not damaged. Bitterbrush is badly damaged, but in some localities it is stimulated into vigorous sprouting from the root crown.

Ease of seeding afterward.—Grain drills may be successfully used for seeding grasses following the cutter on sites where the brush is not heavy, but furrow openers do not penetrate an unusually heavy layer of woody litter. In some trials seed broadcast before brush treatment has been covered by the mulch, and good seeded stands have resulted; but this method is not reliable.

Adaptability to terrain and soil.—Cutters should not ordinarily be used on soils where rocks protrude more than 3 inches above the soil surface. Maintenance and repair costs are high if the blades or flails come into frequent contact with rocks. Moreover, cutters must be operated carefully where the soil surface is uneven or is cut up by small gullies.

Availability of equipment.—Implements of this type are commercially available. Only machines of sturdy construction can be purchased for range use. Cutters with their own power units are preferred for heavy brush.

Effect on erosion hazard.—The woody plant material left as a protective mulch on the soil surface should decrease the erosion hazard. Thus, cutting is a good method of sagebrush control where the probability of wind and water erosion is fairly high and watershed values must be guarded.

Cost of control.—The cost of sagebrush control with cutters is at least $1 more per acre than with plows or disks. Using a 40-horsepower wheel tractor, as much as 2 acres per hour have been covered, but 1 to 1½ acres per hour is average. Higher rates of travel are possible, but it is important that speed not exceed 3 miles per hour if maintenance costs are to remain low and efficiency of control high. Actual costs on several operations during 1962 were $4 to $10 per acre.

General adaptability of cutting for sagebrush control.—Brush cutters work well on stands of big sagebrush that are uniformly old and large, and where rocks are absent or protrude less than 3 inches above the soil surface. They are especially useful for the release of native perennial grasses growing beneath the sagebrush or of seeded stands being suppressed by sagebrush, or where hazard of wind or water erosion is high.

Harrowing

Self-clearing pipe or log harrows, sometimes called Dixie drags, have occasionally been used for sagebrush control, but are most useful for covering grass seed on burned rangelands that are too rocky or rough for the use of other types of implements. They have been used to cover seed on weedy alpine areas and to control rather open stands of old, brittle sagebrush on uneven ground, especially on ranges with numerous rock outcrops.

A 40- to 45-horsepower crawler tractor and a 14-foot pipe harrow make a convenient unit for harrowing. The pipe harrow is simply a series of spiked iron pipes, usually 4 inches in diameter, trailing behind a spreader bar. The pipes, being swiveled, can rotate freely and thus clear themselves of trash (fig. 15). Pipe troughs, fitted over the lead end, prevent the pipes from jumping across one another, especially on sloping ground.

Green logs 6 to 10 inches in diameter can be substituted for the iron pipes, but will last only one season. The fore ends of the logs are notched for holding the chain and swivel. Discarded drill steel or similar bar steel can be used for teeth. The bars are driven through holes of slightly smaller diameter bored in the log. The teeth are held tightly until the log dries.

Harrowing the area once usually suffices to cover the grass seed. Harrowing twice will increase sagebrush kill.

Advantages and limitations of pipe harrowing are as follows:

Kill of sagebrush.—Only 30 to 70 percent of old, brittle big sagebrush and a much lower percentage of younger plants are killed. Higher kills are usually obtained on rocky ground. On rocky sites,

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FIGURE 15.—The self-clearing pipe harrow is useful for thinning sagebrush and covering grass seed on sagebrush ranges that are so rocky or rough that other implements cannot be used.

harrowing gives a much poorer control of low sagebrush than of big sagebrush, and negligible kills of threetip and silver sagebrush.

Kill of associated undesirables.—There is little eradication of such associated sprouting woody species as rabbitbrush and horsebrush. Fall treatment, after seed has germinated, results in fair control of cheatgrass.

Effect on desirable forage plants.—About 10 to 20 percent of the bunchgrasses will be uprooted by the pipe harrow. Damage to bitterbrush is low unless it is tall and brittle. Few plants are killed. Bitterbrush plants examined 2 or more years after treatment showed stimulated sprouting and twig growth, particularly on low, spreading bushes.

Ease of seeding afterward.—Grass seed broadcast ahead of the harrow used for sagebrush control is covered rather effectively in the same operation. Sites where the pipe harrow is necessary are usually too rocky for the grain drill.

Adaptability to terrain and soil.—Pipe harrowing is a practical method on areas where rocks protrude. The harrow clogs badly when used on rock-free or slightly rocky sites and becomes quite ineffective. It is readily usable on sites that are badly cut up by small gullies.

Availability of equipment.—Pipe harrows are not commercially available, but can be constructed in any fairly well equipped machine

shop at a reasonable cost. In areas not reached by roads, log harrows can be readily constructed in the field at low cost with logs cut from green trees nearby; and teeth, swivels, and cable can be brought in by packhorse. Designs and specifications for the pipe harrow can be obtained from the U.S. Forest Service, Washington, D.C., 20250.

Effect on erosion hazard.—Harrowing usually decreases erosion. Litter and debris from uprooted and broken sagebrush left on the loosened ground surface and deposited in gullies, along with the standing brush, protects the soil better than standing brush on untreated areas.

Cost of control.—Harrowing and plowing, on sites to which they are adapted, should cover about the same number of acres per hour at a similar cost. On 125 acres of the Manti-LaSal National Forest in Utah, an average of 1.8 acres per hour was treated with a 28-horsepower tractor and a 10-foot pipe harrow. Computed at 1962 rates, the cost would be $4 to $7 per acre, or about the same as for plowing. Breakage and maintenance costs for harrowing are negligible.

General adaptability of harrowing for sagebrush control.—This implement was devised for soil disturbance, seed covering, and control of open stands of mature sagebrush on moderately to extremely rocky ground. It does a better job on rocky than on rock-free areas. The ripping and gouging action caused by the toothed pipes bouncing along among the rocks tears out some of the sagebrush, loosens rocks, and disturbs the soil enough for seed coverage. The harrow is useful for covering broadcast seed on rocky alpine areas, sagebrush burns, or on areas where sagebrush has been killed by herbicides.

The pipe harrow is an excellent complement to a plow or disk for treating interspersed areas that are too rocky for the plow or disk. By the alternate use of the two implements, all of the area that requires seeding can be treated at one time. The harrow is misused for sagebrush eradication if other machinery gives better results without undue breakage.

Other Methods

Many other methods have been tried in clearing sagebrush for farming or range improvement. Because some of these methods may be useful for sagebrush control, especially if the equipment is readily available, they are briefly described here together with their advantages, limitations, and possible application.

Railing or dragging.—Uprooting or breaking off sagebrush by dragging a heavy rail across it is one of the oldest and cheapest methods of control (fig. 16). This method, widely used in the early days to clear land for farming, has been used for range improvement. The average power requirement for several areas was 1 to 1.8 drawbar horsepower per foot of rail at 2 to 2½ miles per hour.

Even though kill of mature big sagebrush is 30 to 80 percent, the kill of willowy bushes seldom exceeds 50 percent and may be as low as 10 percent. It is usually necessary to rail twice in opposite directions to obtain satisfactory control. Railing has little effect upon crown-sprouting shrubs such as rabbitbrush or horsebrush, and on most grasses and broad-leaved herbs.

Burning is often feasible after one railing where it was not possible

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FIGURE 16.—Rails are useful in breaking off old, mature, and brittle stands of sagebrush. An "A" sagebrush rail which throws the brush in windrows around the ends of the rail is shown here. Later models have been equipped with serrated edges on the side members and two rolling coulters on the cross member to keep the rail from swinging from side to side. Designs and specifications for several types of sagebrush rails can be obtained from the Forest Service, U.S. Department of Agriculture, Washington, D.C., 20250.

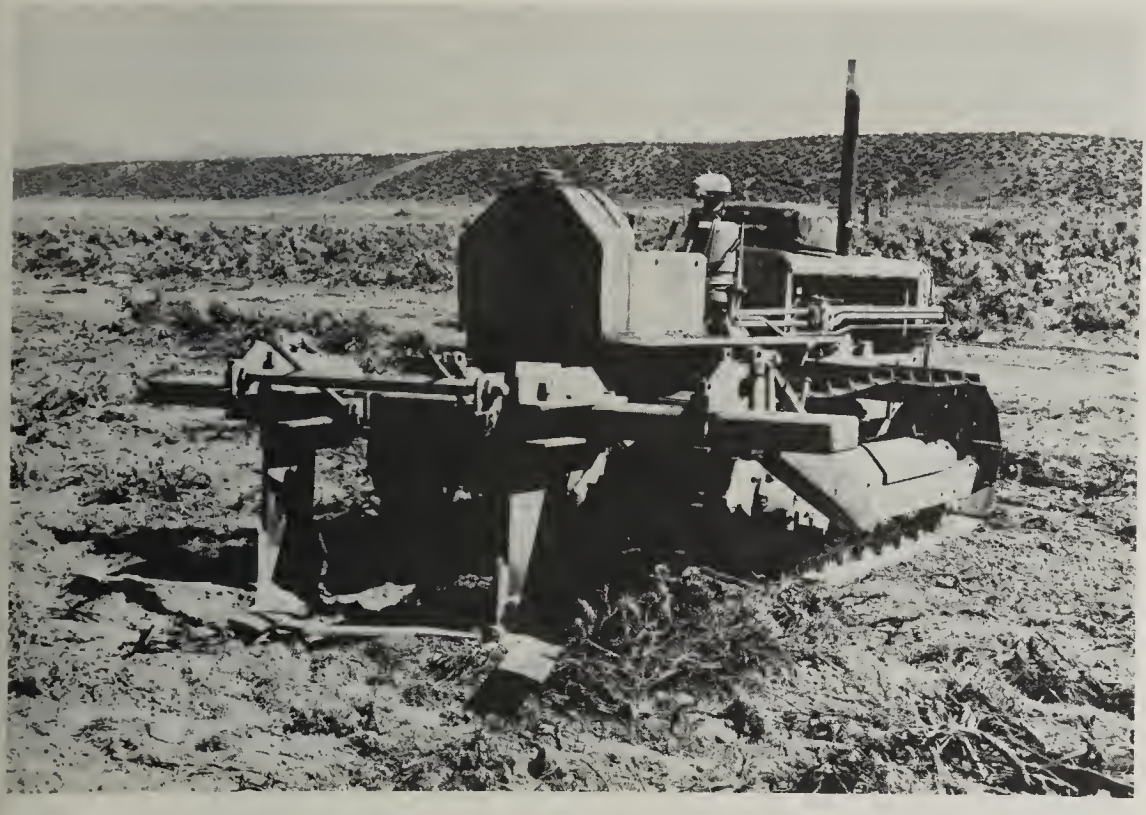
before, and can improve control of uneven-aged stands and make subsequent drilling easier. The piles or windrows of broken and uprooted brush left by railing burn readily.

Breakage of the drag is sometimes excessive on areas that have occasional boulders or rock outcrops.

Railing usually provides poor covering of prebroadcast seed. Drilling is difficult unless the piles of debris are burned beforehand.

Root cutters.—Many types of root cutters, also called planes, blades, grubbers, or cultivators, are available commercially. Root cutters have been widely used for clearing sagebrush land preparatory to farming. The heavier types should be used on rangelands. They consist of from one to five straight or V-shaped blades, mounted on a heavy frame suspended between two wheels or mounted at the rear of a tractor (fig. 17). The blades can be raised or lowered by either a lever or a hydraulic lift, and are set to cut all roots at 4 to 5 inches below the soil surface.

Nearly a complete kill of big, low, and threetip sagebrush of all ages and a fair kill of silver sagebrush can be obtained when cutters are carefully operated. Perennial grasses, broad-leaved herbs, and shrubs that do not spread by rootstocks are almost completely killed. Sprouting shrubs such as rabbitbrush and horsebrush are effectively controlled. Unless sprouting shrubs are mixed with sagebrush, other methods of control may be more suitable. Brush is normally left standing. In heavy rabbitbrush, a chain or cable pulled in a U-shaped loop behind the root cutters overturns the plants. This makes drilling easier and prevents the rerooting of rabbitbrush plants.



BUREAU OF LAND MANAGEMENT PHOTO

FIGURE 17.—Rear view of one type of implement that cuts sagebrush roots effectively on rock-free land. This implement has been particularly effective for controlling rabbitbrush or horsebrush and the clearing of brush preparatory to farming. The blades are usually set to cut 4 to 5 inches below the soil surface.

Root cutters are useful mainly on relatively level and rock-free areas that have deep soils and where the potential production of seeded grass justifies the cost. They are also useful where there is a heavy clay subsoil. They loosen the surface soil but do not turn up the heavy subsoil to form a surface crust, as sometimes occurs with plowing.

With most machines, breakage is excessive wherever large rocks are embedded near the soil surface. It is difficult to keep the blades cutting at a satisfactory depth on uneven ground.

Mowing.—An ordinary power-takeoff mower having a heavy cutter bar, snub-nosed guards, heavy-smooth sections, and a double set of clips to hold the sections snugly against the blunt guards has been found successful for sand sagebrush control in the southern Great Plains. Mowing must be done in June or early July. It has not, however, proved useful for other sagebrush species. Stems of mature big sagebrush are too thick, while small plants and most other species have too many branches near the soil surface that are missed by the mower. It cannot, moreover, be used without excessive breakage if there is much rock lying on the soil surface. The only application that mowing seems likely to have, other than for sand sagebrush, is in the control of young plants that have invaded seeded ranges. For this purpose, herbicides would generally be more satisfactory.

Ripping.—A heavy self-clearing road ripper with teeth spaced 14 to 16 inches apart, pulled by a 30- to 45-horsepower crawler tractor, has been used for thinning sagebrush. With ripper teeth digging 4 to 6 inches, it breaks down or tears up much of the large and old sage-

brush, but kills only about one-third or less of the young plants. About a third of the perennial bunchgrasses are killed. Though some successful stands of crested wheatgrass have resulted from broadcasting on ripped areas, usually not enough of the sagebrush is killed for successful seeding. The ripper can be used with very little breakage on sites that are too rough and rocky to plow, or for loosening up the surface of heavy, tight soils. Ripping is too costly for more than limited use.

Rolling brush cutter.—The heavy type of rolling brush cutter has been tried for sagebrush control. It crushes and cuts up the larger and older bushes of big sagebrush, but kills only a few of the younger plants. Associated sprouting shrubs such as rabbitbrush and horsebrush and annual grasses are not killed. The blades on the rollers are dulled quickly, especially if there is much rock. The rolling brush cutter does not prepare the site adequately for seeding. The roller with spiked teeth instead of cutters appears to be even less effective in killing sagebrush. It is doubtful that these rolling implements have any real value for eliminating sagebrush.

Road graders or bulldozers.—These implements have been used widely on small tracts of land, primarily for clearing sagebrush preparatory to farming. Ordinarily, almost all sagebrush is killed, but the plants are mixed with dirt in windrows and subsequent disposal is difficult. Shrubs, perennial grasses, and other plants, except those that sprout from the roots or spread by rootstocks, are completely destroyed. The method is not effective on rocky ground or rough terrain unless much time is expended. In general, the use of these implements is too costly except on very limited tracts where other more suitable equipment is not available. Both are widely used in constructing firelines before burning.

Flooding.—This is one of the oldest but least widely applicable methods of sagebrush control. It is limited to areas where high spring runoff waters are available. Good kills of big and low sagebrush have been obtained and excellent stands of grass restored by the use of spreader ditches or similar methods for keeping the ground covered or saturated with water for 2 weeks or longer in the spring. Where spring runoff is readily available, this can be done through efficient spreading systems. Silver sagebrush is relatively resistant to flooding. Seed broadcast just before flooding sometimes produces good stands.

REGRASSING AFTER SAGEBRUSH CONTROL

Eradicating sagebrush for range improvement is of little avail unless a good stand of desirable forage plants promptly reoccupies the area. There is great need to get such a stand as soon as possible to protect the soil from erosion, prevent the early return of sagebrush in large quantity, prevent invasion by other undesirable plants, and repay the costs of sagebrush control through a rapid increase in grazing capacity.

Rapid revegetation is needed especially where burning or other methods have destroyed or buried most of the litter. The longer the soil remains exposed, the greater the difficulty to be expected in getting a stand of reseeded grass, and the greater the likelihood of serious

erosion, especially if the soil is somewhat sandy or light or the slopes moderate to steep.

A good stand of perennial grasses is necessary to prevent the early return of heavy stands of sagebrush. Eradication of sagebrush is seldom complete. Plants left alive produce seed that will reinfest adjoining areas unless enough grasses are present in the understory, or are established by seeding, to control the sagebrush seedlings (fig. 18).

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FIGURE 18.—Good stands of grass reduce reinvasion by sagebrush. This range was accidentally burned. The area on the left was seeded immediately to crested wheatgrass. The area on the right remained unseeded; and the next spring it bore an abundant crop of sagebrush seedlings. The unseeded area had over 16,000 plants per acre 11 years later compared with about 4,000 sagebrush plants on the seeded range.

Good stands of perennial grasses also prevent serious invasion by other undesirable plants after sagebrush control. Halogeton, an introduced poisonous annual weed, often invades areas that have been cleared of sagebrush for range improvement or burned. Cheatgrass, an aggressive annual grass, is also quick to occupy areas that have been disturbed by mechanical means or by fire. Successful seeding to perennial grasses may not entirely prevent establishment of undesirable annuals, but these are likely to be so sparse as to provide little competition to perennials. By the second or third year native or seeded perennials should fully occupy the site.

Where there are sufficient undesirable native plants in the understory to reoccupy the land quickly, a sagebrush control method should be used that either selectively controls the undesirable species or destroys most of the understory and permits establishment of seeded grass.

On ranges near irrigated farmlands of Idaho, Utah, and other States, sagebrush control on lands lacking an adequate perennial grass understory may permit invasion of Russian-thistle, tumblemustard, and tansymustard halogeton. These are alternate breeding hosts for the beet leafhopper (*Circulifer tenellus*), an insect that spreads curly top disease to nearby sugarbeet, tomato, and bean crops.

Some ranges have enough desirable perennial grasses and other forage plants growing beneath the sagebrush to revegetate the area quickly after the sagebrush is killed. If these are not destroyed by control operations, and if good grazing management is used after-

ward, there is little need for range seeding. As a general rule seeding is not needed where more than one-fifth of the total plant cover is made up of desirable plants, provided they are fairly well distributed (fig. 3, *A*).

There are extensive areas of sagebrush range without enough desirable plants beneath the sagebrush to revegetate the area quickly (fig. 3, *B*). In these areas, it is advisable to make seeding a part of the sagebrush control job.

Seeding to desirable forage plants should also be planned where sagebrush eradication methods such as plowing or disking, root cutting, ripping, scraping, or burning destroy a high percentage of the stand of perennial grasses.

Seeding may also be desirable to improve forage quality. Where perennial grasses and other forage plants furnish forage of inferior quality or are low in production, more valuable species should be planted after eradicating the sagebrush. Where earlier spring grazing is needed than would be provided by the native grasses, it may also be desirable to seed early-growing grasses. In both these cases, sagebrush control methods that destroy a large part of the understory grasses will be needed to permit establishment of the seeded species.

Information on where seeding is likely to succeed, what species to use, how and when to plant, and what equipment to use in planting can be obtained from several State and Federal publications such as USDA Agriculture Handbook 71, "Seeding Rangelands in Utah, Nevada, Southern Idaho, and Western Wyoming," or from county agricultural agents, State colleges, local Federal officials, or neighboring ranchers who are acquainted with seeding work.

MANAGEMENT OF RANGES AFTER SAGEBRUSH CONTROL

The major aim of management of ranges after sagebrush control should be to encourage continued maximum production of forage consistent with soil protection. This requires that grazing use discourage rather than favor the return of sagebrush, and thus avoid the need of frequent sagebrush removal. Careful management of grazing and the judicious recontrol of sagebrush where objectionable stands recur are the principal means of achieving this aim.

Historical records reveal that a large part of the present sagebrush type had sagebrush as a part of the natural plant cover. Although sagebrush plants were not as thick as at present, their presence indicates their adaptability to the site. Therefore, unless the climate changes, or man alters the site or puts in more competitive plants, the sagebrush will gradually return. Studies to date show that when sagebrush is removed, usually it will again form a sparse to dense stand of brush in from 5 to 20 years after control. The speed and amount of sagebrush reestablishment depends upon the completeness of the stands of native or seeded forage plants, grazing management, and the percentage of the sagebrush that was destroyed. The chances for reinvasion are lessened considerably if the source of sagebrush seed is eliminated over vast areas. This is seldom accomplished with avail-

able methods; burning is virtually the only method that may give complete initial eradication.

Even where initial eradication is complete and good stands of grass develop, sagebrush sometimes returns. This sagebrush may originate from seed stored in the soil or on its surface, or from seeds windblown or carried in by animals. Usually the reestablished sagebrush stands are sparse and not objectionable; but in about 1 year out of 5, conditions favor a dense stand. Poor grazing management, of course, permits the sparse stands to thicken and gradually form dense stands again.

Eradication of newly established sparse or dense sagebrush stands is a major problem. In some cases it pays to get rid of even the sparse seedling stands within 3 to 7 years, before the young sagebrush plants have produced a crop of seed, thereby discouraging establishment of a still thicker stand. Where a good grass understory is present, it is advisable to use spraying, burning, cutting, or other methods that do not seriously damage the grass.

Good grazing management is indispensable after sagebrush eradication, regardless of the method of control or the method of regrassing. *The kind of grazing management practiced is the most important single factor determining whether sagebrush control results in range improvement or deterioration, and how long the range remains free of dense sagebrush* (fig. 19).

In grazing ranges after sagebrush control the following three recommendations have proved worthwhile:

1. *Avoid trailing livestock the first fall and winter across areas where sagebrush has been eradicated.* Trailing the first fall stirs up the soil and speeds erosion. After sagebrush seed has ripened, livestock are likely to carry sagebrush seed from uncleared areas, mostly in their fleece or hair, and scatter it over the cleared areas. Sagebrush seedlings that come up early the following spring will be firmly established before the perennial grasses are big enough to prevent it. Thus, trailing alone can be responsible for the early return of sagebrush.

2. *Delay grazing until native grasses are vigorous and seeded forage plants are well established, as evidenced by seed production.* Where the natural increase of native grasses is being relied upon, it is advisable to delay grazing for at least a full year. An appearance of abundant green growth the first spring is misleading. The dense sagebrush formerly screening the grass and weed understory from view has been broken down or removed, and most of the herbaceous plants on the area are now visible at a glance. Thus there appears to have been a striking increase in forage production, when actually there may have been a decrease. Grazing the first spring usually delays an increase in size and abundance of the perennial grass remnants and keeps the plant cover so open that sagebrush can successfully return. Furthermore, grazing the sparse plant cover disturbs the inadequately protected soil and may speed wind and water erosion.

It is advisable to delay grazing of a seeded range until the first grass seed crop is cast. Earlier grazing may severely damage or even pull out many of the young and weakly rooted grass seedlings. Two full years are usually required for young plants to become firmly rooted,

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FIGURE 19.—A complete sagebrush kill, a good cover of native or seeded forage plants, and good grazing management all prevent or help delay reinvasion by sagebrush. *A*, This area of former sagebrush range seeded to crested wheatgrass is still sagebrush free, largely as result of good grazing management. *B*, A good stand of seeded grasses was established on this range, but extremely heavy grazing for 5 years weakened the grasses. Sagebrush is invading and increasing rapidly.

make vigorous top growth, and produce their first seed crop. In rare instances this stage may be reached and grazing permitted by the end of the first year, but more often it takes at least 3 or more years for seeded grass to attain this stage of development.

3. *Practice good grazing management after the new forage stand is well established.* Whether seeded or native, the stand can easily be damaged by improper grazing practices, especially in drought years. Good grazing management will lengthen the period of good forage production following sagebrush control. To obtain proper grazing intensity, to insure grasses being grazed at the proper season, and to help secure proper distribution of livestock, it may be necessary to fence the seeded and improved areas and to provide better stockwater facilities. Adequate water may be provided by the development of springs, drilling wells, or hauling water by truck to portable troughs. Other recommended practices include open herding, proper location of salt grounds, and rotation grazing. These and all other practices that further good range use should be employed to help maintain the increased grazing capacity and maximum usability of the range resulting from sagebrush control.

Season of grazing use can help maintain a desirable balance between herbaceous and woody plants on sagebrush ranges. Grazing during the fall and winter, when herbaceous species are dormant, does little damage to these species. Sagebrush and other browse species are more readily eaten during this period and are reduced in volume and vigor. Concentrates are often fed to encourage animals to eat browse and dry forage. Care must be taken to avoid trampling wet soil by livestock.

What constitutes good grazing management will vary somewhat throughout the broad range of the sagebrush type with the different classes of livestock being grazed and different seasons of grazing. Additional information can be obtained from county agricultural agents, range extension specialists, State colleges, local Federal officials, or neighboring ranchers who are familiar with good grazing management.

COMMON AND SCIENTIFIC NAMES OF PLANT SPECIES MENTIONED [1]

Grasses and Grasslike Plants

Brome, cheatgrass	*Bromus tectorum*
Fescue, Idaho	*Festuca idahoensis*
Wheatgrass, crested	*Agropyron desertorum*
Wheatgrass, fairway	*A. cristatum*

[1] Nomenclature according to "Standardized Plant Names," Ed. 2, by Harlan P. Kelsey and Wm. A. Dayton, McFarland Co., Harrisburg, Pa., 1942 (except halogeton, recognized later); or "Check List of Native and Naturalized Trees of the United States (including Alaska)," by Elbert L. Little, Jr., Agr. Handb. No. 41, Forest Service, U.S. Dept. of Agriculture, 1953.

Annual and Perennial Herbs

Balsamroot, arrowleaf	*Balsamorhiza sagittata*
Bluebells	*Mertensia* spp.
Geranium, sticky	*Geranium viscosissimum*
Groundsel	*Senecio integerrimus*
Halogeton	*Halogeton glomeratus*
Hawksbeard, tapertip	*Crepis acuminata*
Helianthella, oneflower	*Helianthella uniflora*
Lupine, tailcup	*Lupinus caudatus*
Milkvetch	*Astragalus* spp.
Penstemon	*Penstemon* spp.
Russian-thistle	*Salsola kali* var. *tenuifolia*
Tansymustard	*Descurainia sophia*
Tumblemustard	*Sisymbrium altissimum*

Shrubs and Trees

Aspen, quaking [2]	*Populus tremuloides*
Bitterbrush, antelope	*Purshia tridentata*
Chokecherry [2]	*Prunus* spp.
Cliffrose, Stansbury	*Cowania stansburina*
Douglas-fir	*Pseudotsuga menziesii*
Horsebrush, spineless gray [2]	*Tetradymia canescens* var. *inermis*
Juniper, Utah	*Juniperus osteosperma*
Mountain mahogany, curlleaf	*Cercocarpus ledifolius*
Mountain mahogany, true	*C. montanus*
Pine, lodgepole	*Pinus contorta*
Pricklypear	*Opuntia engelmannii*
Rabbitbrush	*Chrysothamnus* spp.
Rabbitbrush, rubber [2]	*C. nauseosus* and several variants
Sagebrush	*Artemisia* spp.
Sagebrush, big	*A. tridentata*
Sagebrush, black	*A. nova*
Sagebrush, fringed	*A. frigida*
Sagebrush, low	*A. arbuscula*
Sagebrush, sand	*A. filifolia*
Sagebrush, silver [2]	*A. cana*
Sagebrush, threetip	*A. tripartita*
Saltbush, fourwing	*Atriplex canescens*
Saltbush, Gardner	*A. gardneri*
Shadscale	*A. confertifolia*
Serviceberry, saskatoon [2]	*Amelanchier alnifolia*
Snakeweed, broom	*Gutierrezia sarothrae*
Snowberry [2]	*Symphoricarpos* spp.
Winterfat	*Eurotia lanata*

[2] Plants sprout heavily from stem base and roots.

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THE NATIONAL COOPERATIVE DAIRY HERD IMPROVEMENT PROGRAM HANDBOOK

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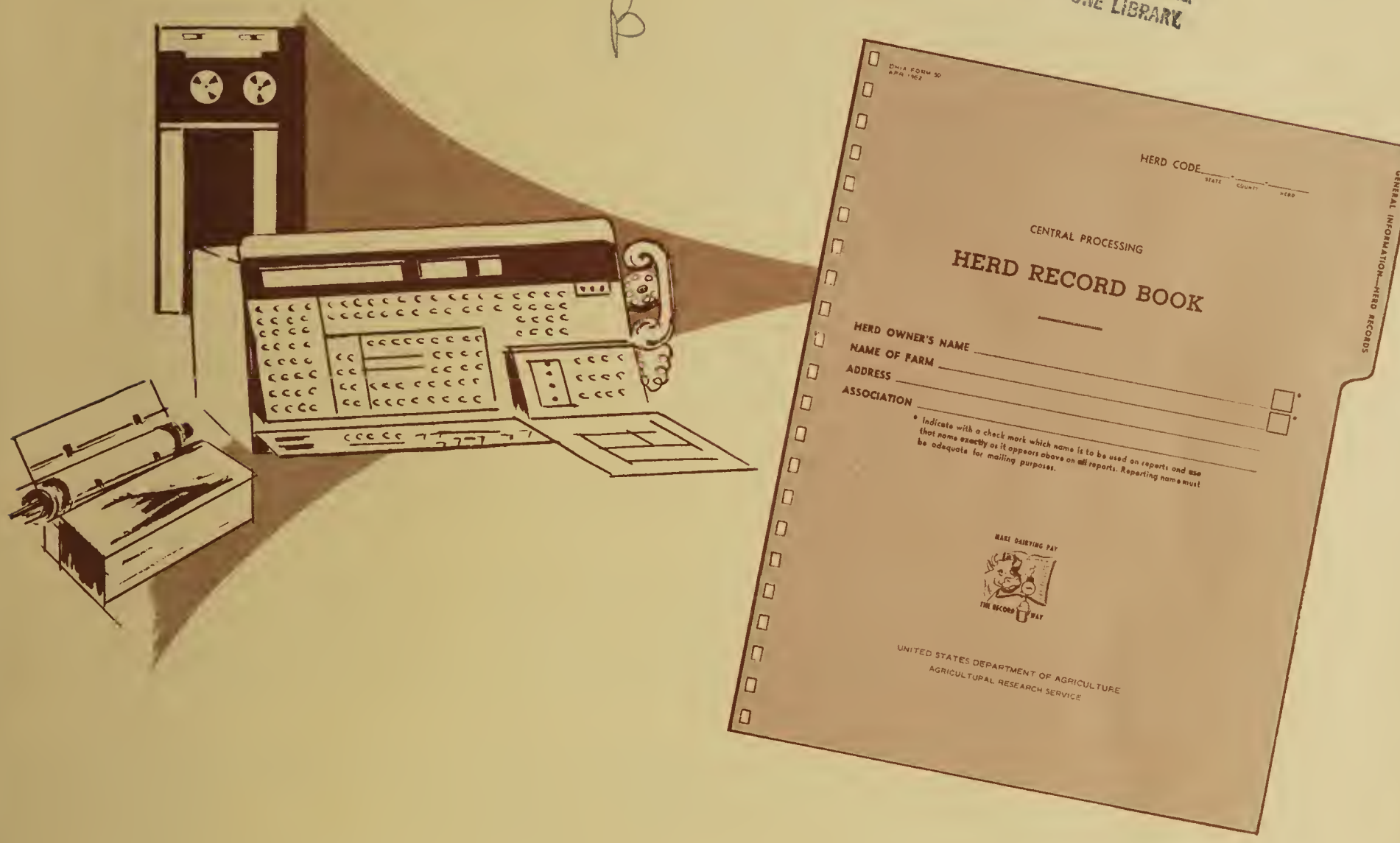


Agriculture Handbook No. 278

Agricultural Research Service

U.S. DEPARTMENT OF AGRICULTURE

The Supervisor's Job

As an employee of a dairy herd improvement association, the supervisor is largely responsible for the accuracy and completeness of herd records. His position can be looked upon as that of operating manager. His ability will help the members of his association. In turn, his doing a successful job will bring credit to himself.

To be successful, the supervisor must be enthusiastic about dairying, and he should have a knowledge of up-to-date methods of breeding, feeding, and managing a dairy herd. He should be trained thoroughly for his work, because most of it requires special knowledge and skill.

The supervisor must report milk production and concentrate consumption for each cow in the herd, report milk price and forage amount and quality on a herd basis, and keep complete records so the dairyman can use the information as a guide in feeding and culling the herd for more efficient milk production. He must also keep complete, up-to-date identification records on all animals in the herd, so the dairyman can use the production records in a progressive breeding program.

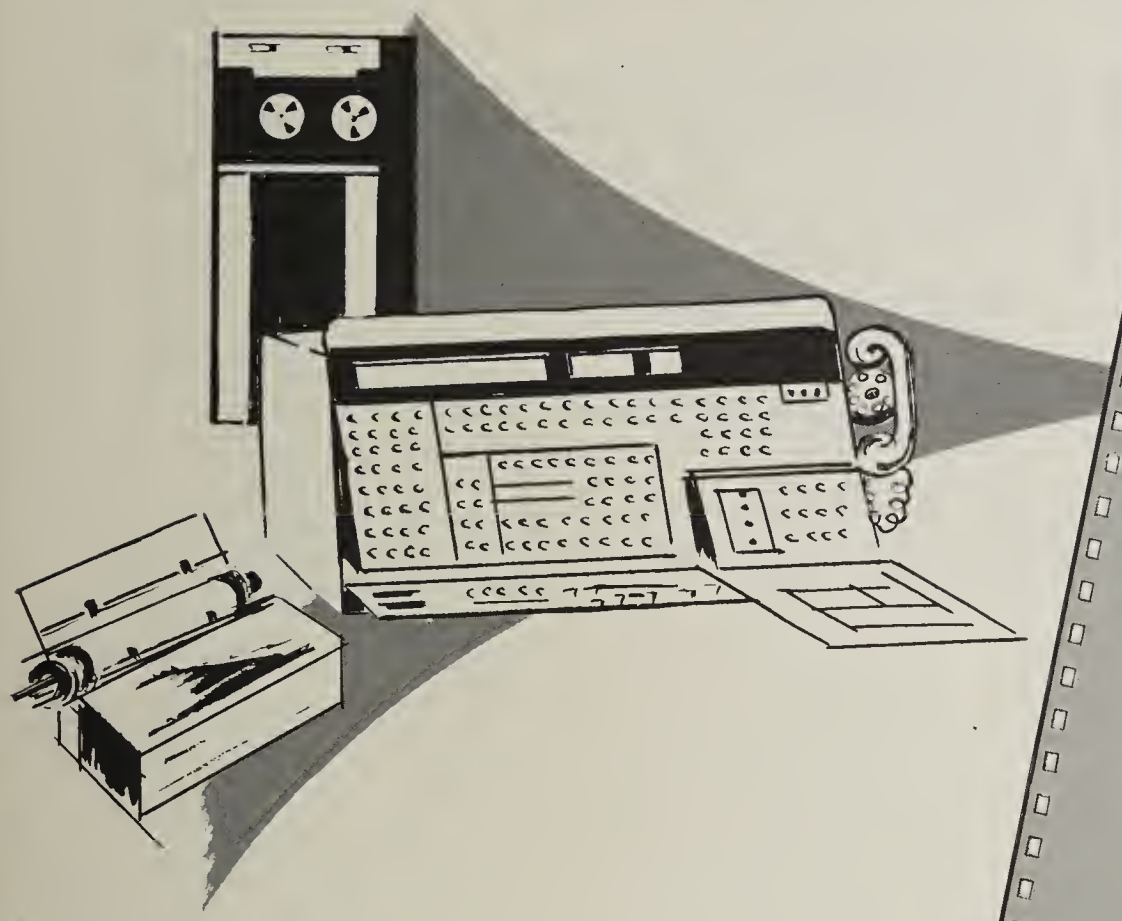
The supervisor's records and reports are used not only by the individual dairyman and by the association, but also by the State extension services and the Dairy Cattle Research Branch at Beltsville, Md. They are used in research and educational programs and are a vital part of the USDA Sire Evaluation Program. It is most important that the supervisor fill out completely and properly the forms used in the association work. He should understand thoroughly the information wanted about each item in these forms and how to record it properly.

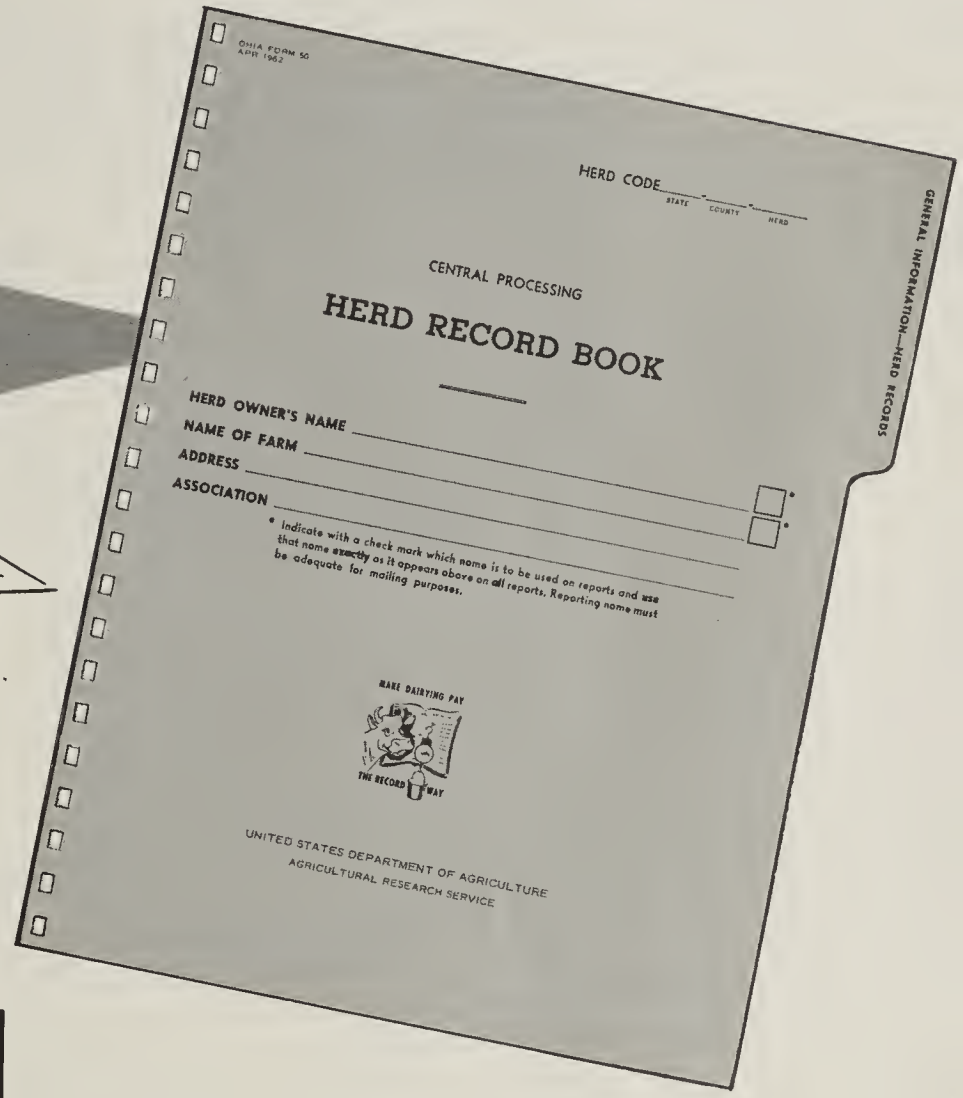
Because of the accuracy required in collecting and reporting the identification, production, and feed records, well-trained supervisors are of vital importance to the successful operation of the whole dairy herd improvement association program.

The purpose of this handbook is to provide the supervisor with the rules to follow in conducting DHIA work, general instructions for obtaining the production and feed records required, instructions for making the necessary identification of animals, and general instructions for preparing the various reports. This handbook, along with materials furnished by computing centers and State extension workers, provides the necessary reference material for the supervisor and instructor.

The supervisor should study the handbook carefully and refer to it frequently to insure that his work in the association always conforms to the high standards of the dairy herd improvement association program.

THE NATIONAL COOPERATIVE DAIRY HERD IMPROVEMENT PROGRAM HANDBOOK





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Contents

		Page
Chapter I.	The National Cooperative Dairy Herd Improvement Program	1
Chapter II.	Outline of Supervisor's Work	4
Chapter III.	Equipment for Weighing, Sampling, and Testing Milk	6
Chapter IV.	Weighing and Sampling Milk	9
Chapter V.	Testing Milk	11
Chapter VI.	Interpreting the Testing Period	14
Chapter VII.	Reporting Data for the Testing Period and Special Situations	16
Chapter VIII.	Calculating Records	19
Chapter IX.	Feed Reports	21
Chapter X.	Identification Records	22
Chapter XI.	Herd Improvement Through Breeding	24

Appendix

Memorandum of Understanding	27
DHIA Rules	29
Rules Applying to DHIR Testing	32
Table 1. Centering Date Table—Monthly	33
Table 2. Centering Date Table—Bimonthly	34
Table 3. Estimating Missing Monthly Test-Day Records	34
Table 4. Monthly Test-Day Record To Be Estimated	36
Table 5. Calculating Age in Months	37
Table 6. Year-Day Table and Examples	38
Explanation of Sire Summary Record 1202	39
Figure 1. USDA–DHIA Sire Summary Record, DHIA–1202	41
Figure 2. Supervisor's Work Sheet for Calculating Lactation Records	42
Interpretation and Use of Error Codes for Lactation Records on Form DHIA–1060	43
Interpretation and Use of Error Codes for Yearly Herd Data on Form DHIA–1080	44

Chapter I. The National Cooperative Dairy Herd Improvement Program

The primary purpose of the national cooperative dairy herd improvement program is to afford the individual dairyman an economical method of obtaining information he can use to improve the producing efficiency of his herd. The records of identification, production, feed cost, and income enable the dairyman to cull the least profitable cows, to feed the rest according to their production requirements, and to select the most suitable animals for breeding up the inherent producing ability of his herd. Thus, keeping accurate feed and income records is an important part of the recordkeeping program.

Dairy herd improvement associations are important as a service to the dairyman, as agricultural extension demonstration projects, as a source of information for sire evaluation, and for research studies. They are operated under the supervision of State extension workers and county agricultural agents, in cooperation with the Federal Extension Service and the Dairy Cattle Research Branch of the U.S. Department of Agriculture. The records from associations are used by extension personnel to demonstrate to nonmembers the value of the program.

Dairymen join an association, however, for the service it offers; and a group of dairymen—once convinced of the value of the dairy herd improvement program—organizes an association and employs one or more supervisors to provide a service, cooperatively for themselves.

A Dairy Herd Improvement Association

A dairy herd improvement association is an organization of dairy farmers who keep records by one of the following recordkeeping plans: the Standard DHIA plan, the Owner-Sampler plan, the Weigh-a-Day-a-Month plan, or any combination of the three. The members of the association elect a board of directors, and officers are elected either by the total membership or by the directors. The directors and officers conduct the business affairs of the association. They employ the supervisor, establish the testing charges, enforce the DHIA rules, and conduct such other business as may be required.

The supervisor determines the production of each cow in the herd and maintains animal identification and other records as required by the DHIA rules, the association board of directors, the county agent, the State extension dairyman, the computing center, and the USDA.

The association employs as many supervisors as are needed to conduct the testing work in the herds enrolled. Some associations operate a central testing laboratory where the milk samples are tested.

Statewide Organizations

In some States, the local associations have formed statewide organizations, or federations, which usually are financed by assessing member associations on a per-cow basis. The locals elect a board of directors for the State association, usually through delegates at the annual meeting. A State organization, in cooperation with the State agricultural college or university, can render valuable service to the dairy herd improvement program in the State in the following ways:

(1) Establish State DHIA policies and rules; (2) coordinate the programs of the local associations; (3) interpret and enforce all DHIA rules uniformly throughout the State; (4) establish standards of performance for supervisors; (5) determine the status of the local associations for income tax purposes; and (6) arrange on a statewide basis such things as compensation and liability insurance for the supervisors and social security payments.

The Standard DHIA Plan

Regardless of the type of organization and method of operation, recordkeeping in herds under Standard DHIA is conducted as outlined in this handbook and according to the rules given in the appendix. Records obtained from herds on the Standard plan are used in the USDA sire evaluation and research program and by colleges and universities for research and educational purposes.

Usually a supervisor schedules 1 standard herd per working day, although on the average he will service 17 herds a month. The remainder of his time he will work with Owner-Sampler herds.

The Owner-Sampler Plan

As the name implies, in the Owner-Sampler plan, the herd owner records milk weights and takes samples for each cow in his herd. The samples are tested either by the supervisor when he visits the farm or in the central laboratory if one is operated. The records are processed at the computing center and are used by the dairyman for herd improvement purposes. The records are not used in the USDA sire evaluation program or for research, since the milk weights and samples were not obtained by the association supervisor.

In addition to Standard herds, it is usually beneficial for supervisors to service as many Owner-Sampler herds as possible. Many alert supervisors service more than 70 Owner-Sampler herds.

The Weigh-a-Day-a-Month Plan

The Weigh-a-Day-a-Month (WADAM) plan is very simple, requiring as little time and effort of a dairyman as is consistent with helpful recordkeeping. It is intended to supplement, stimulate, and complement the Standard DHIA and the Owner-Sampler plans. WADAM is usually handled through the county agent's office or the computing center, or both. It consists of the dairyman's weighing the milk produced by each cow on one day each month and reporting to the county agent or a computing center the milk weight; the plant butterfat test for the month; freshening, dry, purchase, selling, and death dates; and feed records (if desired). The computing service agency returns the calculated records to the dairyman who uses them as a guide to feeding, culling, and breeding. Although the records are unofficial, as are the Owner-Sampler records, they are of great value to the dairyman. This plan costs less than either the Standard or Owner-Sampler plans.

Dairy Herd Improvement Registry

The Dairy Herd Improvement Registry (DHIR) record is an electronically computed Standard Plan DHIA record intended to eliminate much of the duplication of cost and effort caused by the use of both the DHIA and the Herd Improvement Registry (HIR) testing programs, but with some additional requirements to meet the needs of the dairy breed organizations.

DHIR and Standard DHIA records are processed in the same manner at the State or regional computing center. A dairyman who wishes to enroll in the DHIR plan must apply to his breed association on appropriate forms, pay the required fee as established by the breed association, notify his extension dairyman, and agree to follow the rules applying to both Standard DHIA and DHIR. (The rules are included in the appendix.) The DHIR records processed by the State or regional computing center are forwarded to the respective breed association.

Broad Program of Herd Improvement

Since the beginning of cow testing associations in 1906, DHIA has grown to include, in 1964, a total of 2,822,522 cows in 67,664 herds located in the 50 cooperating States and Puerto Rico. This membership is serviced by 1,420 local associations and 2,474 supervisors. The total program is carried out through the cooperative efforts of DHIA members, local association directors and officers, central testing laboratories, county agricultural agents, State extension workers, State associations, State or regional computing centers, and the Federal Extension Service and the Animal Husbandry Research Division of the U.S. Department of Agriculture. The broad purposes, objectives, and responsibilities relating to the National Cooperative Dairy Herd Improvement and Sire Evaluation Programs are provided in a memorandum of understanding between the State Cooperative Extension Service, and the Federal Extension Service and the Animal Husbandry Research Division of the USDA. The memorandum is included in the appendix. This memorandum of understanding is also applicable to working relations between State DHIA organizations and local associations.

Records for Sire Evaluation and Research

Although each DHIA benefits its individual members, the information obtained from these associations is extensively used also on a nationwide basis. Production records from Standard DHIA and DHIR herds are provided by State or regional computing centers to the USDA in the form of either punched cards or magnetic tapes. In 1963, 1,320,423 lactation records were provided. These records are screened for accuracy, and by use of high-speed magnetic tape equipment, they are added to existing files and used for sire evaluation and research purposes.

The sire evaluation program, which provides sire evaluation services on a nationwide basis, is based on production differences between the daughters of a bull and their contemporary herdmates.

Because the use of superior sires is the surest and quickest way to improve the inherent producing ability of dairy herds, the Dairy Cattle Research Branch and the State extension services are cooperating in a nationwide program to evaluate all sires used in association herds and to aid in disseminating and perpetuating the hereditary influences of the outstanding sires. The herds from which these good sires come can become sources of breeding stock for improving the Nation's dairy cattle.

The records obtained in the Standard plan are also used to develop educational programs and research to aid the dairyman in improving the productivity and income from his herd through better breeding, feeding, and management practices.

Importance of Recordkeeping

Profitable dairying is realized through sound breeding, feeding, and management, each of which may be the limiting factor. High levels of production cannot be obtained from cows of inferior breeding no matter how well they are fed and managed. Likewise, cows of excellent breeding will not produce well in the absence of sound feeding and management.

Sound breeding emphasizes culling and selection of both cows and bulls. The low-producing cows must be recognized and culled as soon as possible to increase the productivity and profitableness of the herd. Low-producing cows usually can be detected after one lactation or, by alert dairymen, after only 3 to 4 months of lactation. It is important also that dairymen recognize and use the best bulls available, since this is the surest and most rapid way to bring about genetic improvement. The information needed in selecting bulls, especially those available in artificial breeding, is provided by the USDA Sire Evaluation Program.

Sound feeding and management consists of feeding good quality feed to each cow according to her current level of production and care as needed to insure optimum performance. The feeding program should be flexible, so that the relative amount of grain and forage fed may vary according to feed available and market demands.

Recordkeeping is not only desirable but essential for profitable herd performance. It requires that each cow in the herd be production tested to permit sound breeding, feeding, and management. In this way, individual cows can be culled or fed according to known producing ability and bulls can be selected with greater

reliability. This can be realized through membership in a dairy herd improvement association.

Cows enrolled in Standard DHIA have in the past produced from 60 to 80 percent more milk and butterfat than all other cows in the United States. Shown below are these production comparisons for selected years from 1930 to 1963.

Year	Standard DHIA cows		All other cows in the U.S.	
	Milk (lb.)	Butterfat (lb.)	Milk (lb.)	Butterfat (lb.)
1930	7,642	303	4,435	174
1940	8,133	331	4,519	175
1950	9,172	370	5,118	202
1962	11,032	426	6,919	256
1963	11,286	434	7,029	260

Use of production records has been largely responsible for the superior performance of cows and herds being production tested. The following results, which represent Standard DHIA herds in the United States in 1964, show how these records enable the participating dairyman to increase not only production but also herd efficiency.

Milk production (pounds)	Value	Feed cost	Income over feed cost
Low Fat Production (3.6–3.8 percent)			
6,000	$276	$155	$121
8,000	351	177	174
10,000	424	203	221
12,000	506	232	274
14,000	601	267	334
16,000	688	293	395
High Fat Production (5.0–5.2 percent)			
6,000	$320	$151	$169
8,000	430	187	243
9,900	552	235	317

A dairyman can increase his net profit and help control the milk surplus by selling unprofitable cows for beef. To be profitable, a cow should produce at least $2 worth of milk for each $1 worth of feed she consumes. By disposing of unprofitable cows, a dairyman increases his net income and at the same time removes their milk from the market.

Proper and complete identification records coupled with impartial recordkeeping not only can provide information needed to cull intelligently but also can add to income. Grade and registered heifer calves, young heifers, and cows all bring more when a dairyman has records to prove the animal's worth. Anything above cost is more return on investment—a result of the use of a good recordkeeping system.

Accuracy of Records

High-speed electronic computers are being widely used to process DHIA records. As a result, greater accuracy is obtained in the overall recordkeeping system. However, no amount of data processing will replace the importance and need of accuracy by supervisors in recording data on the farm. Especially important is the accurate and prompt identification of calves, heifers, cows, dams, and sires and the proper recording of change of status codes and dates as they affect advancing lactations of cows. Also important is the accuracy of feeding and related management information, which is essential to the dairyman.

Recordkeeping data from Standard DHIA herds are used more and more extensively for the important work of research and sire evaluation. The reliability of these efforts, along with their usefulness to dairymen, depends largely on how completely and accurately the data are recorded by each supervisor.

Making DHI Information Public

Local publicity is valuable to association work in the community. The supervisor should cooperate with the board of directors and the county agent in preparing news articles. Stories that illustrate a recommended practice should be used in preference to mere statistical accounts. The real purpose of the testing work is to improve each individual herd. Stories of outstanding sires summarized in the association are of interest to all dairymen in the community. Herds in which unusual improvement has been made through association work are also good material for news stores.

Chapter II. Outline of Supervisor's Work

The daily routine of supervisors varies widely because of the use of automated data processing (ADP) procedures, the inclusion of Owner-Sampler testing in the routine of some supervisors having herds on the Standard plan, and bimonthly testing and the use of a central testing laboratory in some areas.

Regardless of the operating plan of the association, the DHIA supervisor's work is essentially as outlined in this handbook.

Although use of ADP procedures has reduced the calculating work required of supervisors, *complete and accurate reports are absolutely necessary.* It is vital to follow exactly the instructions given by the computing center for reporting the various components of the record. *Follow carefully the instructions in this handbook for reporting names, code numbers, and other figures in the record, and for the proper forming of letters and numbers to make them readable.* When incorrect data are used for any purpose, the published information loses its value.

To assist in maintaining uniformity and reliability in the Standard DHIA recordkeeping plan, rules have been established by the American Dairy Science Association and are shown in the appendix. The principal points of the rules are: (1) In each herd all weighing and sampling of milk must be done by the supervisor; (2) the testing of milk must be done either by the supervisor or by personnel of a central testing laboratory; (3) all cows of milking age in the herd, including dry cows, must be on test, regardless of ownership; (4) all cows, including dry cows, that have been on test in the herd during the year must be included in the yearly herd average; and (5) the supervisor (the term "supervisor" may include personnel of a central testing laboratory) must use or report the data obtained on the testing day as the basis for computing the production for the corresponding testing period.

These rules must not be modified. It is the supervisor's responsibility to see that the rules are followed. If any basic rule is not followed, records should not be reported or compiled as Standard DHIA records. General confidence in DHIA records is maintained and enhanced when all Standard DHIA testing work conforms with DHIA rules. Any supervisor who makes exceptions to the rules, or permits any association member to make exceptions, loses the confidence of that member and all other members of the association. Questions about interpretation of the rules should be referred to your board of directors.

Duties of the DHIA supervisor, while on the farm, are outlined generally as follows:

Evening Work

1. Arrive at the farm early enough to avoid causing any delay in the evening milking.
2. Before milking time, fill in all items not completed in the heading of the prelisted barn sheet.
3. Eartag all calves that have entered the herd since the last testing day unless they are otherwise suitably identified. Record the identification on appropriate forms. (See ch. X for eartagging procedures.)
4. Fill in all dates and change-of-status codes required by the computing center.
5. Positively identify each cow in the herd as the day's feed and milk records are obtained by comparing her markings, eartag number, or other identification with data in the herd-record book.
6. Weigh or measure the grain fed to each cow and determine on a herd basis the amount of forage consumed. Usually with the help of the dairyman you can estimate in the evening the quantity of feed to be fed in the morning. The amount of any feed refused must be subtracted from feed fed, to obtain feed consumed, which is the amount to report.
7. Weigh the milk of each cow in the herd and record weights on the barn sheet.
8. If the milking is done with a bucket milker, mix the milk from each cow thoroughly by pouring it three times from one pail to another; then take the sample. If a pipeline milker and meter are used, take the sample from the sampling device. If there is a weigh bucket or bell jar in the line, allow air to bubble through the milk for 1 second per pound of milk before taking the sample, to insure thorough mixing of the milk.
9. See that numbers on the sample jars of milk correspond with the numbers of the cows in the sample column on the barn sheet. Keep the sample jars tightly closed and securely locked while they are not under your supervision.
10. Immediately after each newly purchased cow is milked, eartag her if she does not have suitable identification and record the identification on appropriate forms.
11. Immediately after each cow that freshened or was purchased since the last visit is milked, use an approved heart-girth measuring tape to estimate live weight and record it in the proper column of the barn sheet and on the cow's individual record sheet.
12. Record the prices of concentrates and good-quality hay in your area. Some computing centers figure prices of all forages from the price of good hay. Record prices of other specific feeds and quality of the various forages if your center requires it.
13. Record the price of milk and butterfat and, if required by the local association, the price of protein and solids-not-fat.
14. Get as much of the required information as possible in the evening. The dairyman is likely to be too busy in the morning to have time to give you the data you need to complete your report. It is probably best to schedule a time to obtain data from the dairyman in order to insure that no item is missed.
15. Strive to assist the dairyman by discussing with him his breeding, feeding, and management program. Feel free to obtain assistance and materials from the county agent, computing center, and extension special-

ist. Become thoroughly familiar with the total recordkeeping system so that you can answer the dairyman's questions.

Morning Work

1. Be on the job before milking time. Weigh or measure the grain fed each cow (if you did not do so the previous evening). Check for feed refusals.
2. Weigh and sample the milk from each cow as at the evening milking.
3. Obtain a composite sample of the evening's and morning's milk of each cow for the butterfat test and, if required by the association, for protein and solids-not-fat test. Greater accuracy is obtained by using proportionate quantities from each milking to collect the composite sample. If your testing work is done by a central laboratory, be sure that the composite samples are packed so as to prevent breakage during the trip to the laboratory. Otherwise, test the composite samples as required.
4. Transfer data from the barn sheet to the individual cow-record forms as needed.
5. Be sure that all entries for which you are responsible are complete in the dairyman's herd-record book.
6. Before you leave the farm, recheck all phases of the work to be certain that all items on the barn sheet are filled out properly, all individual cow records are brought up to date, and all necessary new identifications have been made. If you do not complete this work properly, the dairyman may justifiably think that you are not capable of handling the job.

Chapter III. Equipment for Weighing, Sampling, and Testing Milk

The procedures outlined in this chapter and in chapter V are in line with good recordkeeping practices. The equipment described is approved for use if no specific State regulations exist.

Weighing and Sampling Equipment

1. Two seamless large-capacity milk pails.
2. Field case with padlock for the following equipment:

a. *Scales.*—A special milk scale is required. It must have a capacity of 60 pounds, an adjustable hand, and a legible dial graduated in pounds and tenths of pounds; and it must be accurate within the limits set by the American Dairy Science Association (appendix, DHIA rule 1b).

b. *Milk-sample jars of 3- or 4-ounce capacity for each cow in the herd.*—They must be fitted with watertight lids or stoppers. Each sample jar and lid must be permanently numbered or have a place for recording the assigned sample number.

c. *Trays to hold sample jars.*—A wire mesh lid for each tray makes it possible to dump and wash a tray of jars at a time.

d. *Sampling device.*—A 30-ml. sample dipper (heavy type with rounded bottom), syringe, or milk-thief.

e. *Preservatives.*—Suitable preservative tablets, such as bichloride of mercury or sodium dichromate, must be used to preserve samples when they cannot be tested on the day they are taken or cannot be maintained between 30° and 40° F.

Testing Equipment for the Babcock Test

1. Electric centrifuge (24 or 36 bottles) with speed and heat control.—The heat control must maintain an operating temperature of 135° to 150° F. The operating temperature of the centrifuge should permit no appreciable rising or lowering of the fat columns when test bottles are transferred to the water bath. The operating speed must be controlled within the following (tolerance ±25 r.p.m.):

Diameter of wheel (inches):	*R.p.m.*
18	800
20	759
22	724
24	693

Diameter of wheel is the distance between the bottom of the opposite cups, measured through the center of rotation when the cups are extended horizontally. Check the speed of the centrifuge at least monthly with the door of the centrifuge closed. An accurate tachometer permanently attached to the centrifuge is desirable.

2. Field case with padlock for the following equipment.

a. Approved Babcock test bottles.—Specifications: 8-percent, 18-gram, 6-inch milk test bottles, with 0.1 percent graduation. Test bottles must be unbroken, clean, and numbered consecutively or to correspond with the numbered sample jars.

b. Approved pipettes.—Each laboratory or place of testing must be equipped with three or more approved pipettes, calibrated to contain 17.6 ml. of water at 68° F.

c. Acid measuring devices.—Burettes, dippers, or other satisfactory acid measuring devices that will deliver 17.5 ml. of acid into the test bottle without spillage.

d. Acid bowl.—Approximately 5 inches in diameter and 4 inches deep, if a dipper is used.

e. Electric heater for water bath (small hotplate) if an electrically heated and controlled water bath is not used.

f. Water bath.—The water bath must maintain water at 135° to 140° F. The tank should be copper or other rustproof material marked with indentations to indicate the proper water level (top of fat columns for either 12, 18, or 24 test bottles).

g. Bottle rack to go in water bath.—The rack should have partitions between bottles and holes in the bottom of rack. The holes should not be directly underneath the bottles.

h. Shield to hold test bottles in position in rack and some device to hold the rack and bottles in position when they are submerged for washing.

i. Thermometers.—Two or more accurate milk thermometers (floating, 20° to 220° F.).

j. Calipers or other approved reading devices for measuring the fat columns.—Calipers must have parallel needle points and adjustable tension.

K. Acid hydrometer.—A sulfuric acid hydrometer (1.80 to 1.85 sp. gr. at 68° F.) must be available to check the specific gravity of the acid. If acid is too strong (above 1.825 at 68° F.), the following adjustments can be made:

(1) Use a suitable acid bottle, polyethylene, or stainless-steel container. An ordinary glass jug may break from heat.

(2) Add one pipette (17.5 ml.) of water per quart of acid for each 0.005 drop in specific gravity required.

(3) Add slowly a small amount of acid, and mix. When the container has been uniformly heated, add additional acid until required specific gravity has been attained.

l. Three brushes.—1 test-bottle brush; 1 sample-jar brush; 1 pipette brush.

m. Small oil can and oil.

n. Cow marking crayons.

o. Dixon 352 white pencil.

p. Weight tape measure.
q. DHIA eartagging outfit.
r. Extension cord with a 3-prong plug-in socket or 2-prong socket with grounding wire.

3. Sulfuric acid.—Sulfuric acid for the Babcock test, having a specific gravity of 1.82 to 1.825 at 68° F., must be plainly labeled and stored in safe containers with tight stoppers or lids.

4. Carrying case with padlock for acid jug.

5. Water.—A supply of clean water must be available for washing equipment and making the tests. Water at 150° F. or above must be available to add to the test bottles while the test is being made.

6. Reading light.—Each laboratory or place of testing must be equipped with a suitable diffused light located at eye level height so as to give a clear outline of the fat column.

Other Recommended Equipment

1. A case for record forms.

2. Moisture tester.—A moisture tester is a very useful tool for determining the actual moisture content of green feed and silages. Actual moisture values will likely be more accurate than values on coding charts.

3. Test bottle shaker.
4. Test bottle washer.
5. Acid pump.
6. Automatic timing device.
7. Double wash sinks.
8. Acid disposal sink.

Equipment For TeSa Test

Equipment for the TeSa test is assembled into a kit by the manufacturer and should be ordered as such. The amount of glassware included in the kits varies, in order to serve herds of different sizes. The manufacturer is Technical Industries, Inc., 2711 SW. 2d Ave., Fort Lauderdale, Fla.

Equipment for Protein and Solids-Not-Fat Determinations

The procedures for determining protein and solids-not-fat (SNF) are relatively new. If such procedures and equipment are needed, consult your local board of directors or State extension dairyman and include any printed material about these tests with this handbook.

Equipment for a Central Laboratory

The standards for equipment are the same for central laboratory testing as for field testing. The only differences are the number of each item stocked and the storage facilities needed.

Care of Testing Equipment

The condition and appearance of the testing equipment often indicate the quality of work being done. Keep equipment clean and in good operating condition at all times. While most of the equipment listed is for the Babcock test, other equipment requires the same general care and cleaning procedures.

Centrifuge

Keep the centrifuge clean. Oil it frequently with a high-grade lubricant. Keep it adjusted properly and in repair. For repairs, see your board of directors. Operate the centrifuge only on a level, firm foundation. Start and stop the machine slowly.

Scales

Keep the scales clean and free from rust. Do not drop or overload them. Wrap the scales in a dry cloth and keep them in a kit or dry box when not in use. Check the accuracy of the scales frequently, especially if they are old. Methods for checking accuracy are described in chapter IV. With inaccurate scales, you can obtain only worthless, misleading records, and you are wasting your time and the dairyman's money.

Glassware

Glassware is expensive. Use, store, and carry it with care. If your supervisor's kit does not provide a specific place for the glassware, wrap it separately and carry it so jarring or shifting of equipment will not cause breakage.

Acid

Acid will burn holes in clothes and will burn the skin. In fact, it will burn or damage practically everything (except rubber or glass) with which it comes in contact. You must regard the acid as dangerous and handle it accordingly.

If you accidentally spill acid on your skin, wash it off immediately. It is good practice to keep your hands wet while pouring the acid. Keep baking soda in your kit, handy for use in neutralizing spilled acid. To bring acid to the proper temperature, place it in a warm room in the evening, if possible. If the acid must be warmed in the morning, place the jug in a warm-water bath. If the acid and jug are cold, warm the jug in a lukewarm-water bath. Never place the jug in hot water or on a stove to warm it; the heat may crack the jug and permit the acid and water to mix, which would cause an explosion with probably disastrous results.

Always keep acid away from children. After you have completed the test, empty the test bottle and any milk to which you added preservative on an ash pile or some place where children or animals cannot get to it. Do not empty test bottles down a drain; the acid will damage the plumbing and may interfere with the bacterial action where septic tanks are used.

Carrying Case for Acid Jug

Carry acid in a strong, glass jug with a hard-rubber stopper. Carry the jug in a strong, locked, wood case. The case should be made of not less than ¾-inch material, and it should be padded on the sides and bottom to fit the jug snugly. It should be just deep enough so that when the lid is closed and locked, it automatically holds the jug stopper firmly in place. Keep the jug in the case at all times except when warming the

acid in a water bath. When carrying the acid in a car, place it so that it will not tip over and so that in case of a traffic accident it cannot spill on the occupants of the car.

Cleaning Equipment

Test Bottles

1. While they are still hot, empty the test bottles in a safe place where acid will do no damage. Shake the bottles while emptying them, to keep sediment from sticking to the glass.
2. Rinse the bottles with cold or lukewarm water.
3. Replace the bottles in the water bath. Add a good dairy cleaner (not soap); put a little cleaner in the neck of each bottle.
4. Add hot water to the water bath until water fills the test bottles.
5. Wash the bottles thoroughly; use a stiff brush on the necks of the bottles. If dirt has accumulated inside the bottles, add BB shot with the cleaner, and rotate the bottles vigorously.
6. Empty the bottles; rinse with warm water; and invert to drain.
7. Rinse with hot water and invert to drain and dry.

Other Equipment

1. As soon as possible after use, rinse the sample bottles, pails, dippers, and other equipment with cold or lukewarm water.
2. After rinsing, scrub thoroughly with a stiff brush, using hot water and a good dairy cleaner.
3. Follow the washing operation with a hot-water rinse—the hotter the water, the better.
4. A final rinse in a chlorine solution (200 parts per million) or quaternary ammonium compound solution will destroy bacteria on the equipment and help to keep future milk samples from souring.
5. Invert and air-dry the equipment to prevent rust.

Source of Supplies

Your board of directors will advise you as to where and how to obtain supplies, equipment, glassware, acid, alcohol, TeSa reagent concentrate, and other materials.

Chapter IV. Weighing and Sampling Milk

Responsibility of Supervisor

The cows being milked must be located so that you can observe the milking at all times. It is your responsibility to check the weighing device for accuracy before milking, to weigh all milk or observe the weight being accumulated for all cows, to record the weights on the barn sheet, and to take and preserve the milk samples for testing.

Weighing and Sampling When a Bucket-Type Milker Is Used

It is preferable to use varying standard weights, which you can obtain from your board of directors, to check the accuracy of a dairy scale. A scale should meet the standards set by the American Dairy Science Association (appendix, DHIA rule 1b) or the standards in your State, whichever are higher. A bucket of known weight and various measures of water (8.3 pounds equals 1 gallon) can also be used.

Weighing

Hang your scales at eye-level height at a place in the barn where you can observe all milking operations at all times. Adjust one hand on the milk scale so that it will rest on zero with the empty, but wet, pail. Always read the adjusted hand and record the milk weight to the nearest "tenth" of a pound.

Sampling

At each milking, pour the milk of each cow from one pail to another three times to insure that the milk is mixed thoroughly before you take a sample. The test will be more accurate if you use proportionate quantities from each milking to make up a composite sample for each cow. This is best done by placing a full sample dipper of milk from the first milking in the sample bottles and then varying the amount of milk added from the next milking according to the weight of the milk obtained from that milking. For example, if the second milking is heavier than the first, add a full dipper plus a little additional milk. If the second milking is lighter, add less than a full dipper of milk from that milking. The composite sample should always be large enough to run two tests if necessary. Also, the sample should be large enough to provide milk for other tests if it is being tested for more than one factor.

Weighing and Sampling When Pipeline Milkers Are Used

Various systems of weighing and sampling milk from individual cows have been developed for use with pipeline milkers. One weighing and sampling device—the Milk-O-Meter—has been approved by the American Dairy Science Association and the State regulatory agencies for use in the Standard DHIA program. See appendix, DHIA rule 1, for the requirements to be met by any equipment used in the Standard program.

Proper Installation and Use

Proper installation and use of any weighing and sampling device is important for accurate results. You are responsible for the accurate weighing and sampling of each cow's milk. You should become familiar with the operation of the device before using it in the Standard DHIA plan. Most manufacturers provide instructions for the correct installation and operation of weighing and sampling devices. You should study them carefully.

Procedure for Using Weighing and Sampling Devices

Collection Containers in Milkline From Cow

Attach collection containers in the milkline between the cow and the pipeline to collect each cow's milk separately. The containers may be milker pails, milk cans, or similar vessels with special covers for trapping the milk. Check to see that the container is empty before each cow is milked. When the milking for each cow is complete, cut off the vacuum from the milkline, and empty the milk into your weigh pail. Weigh and sample the milk in the usual manner.

Milker Pail or Bell Jar With Scales

1. *Checking for accuracy.*—Remove the pail or jar from the scales, and test the scales as described earlier in the chapter.

2. *Weighing.*—Weigh according to the following procedure:

a. Be sure that the adjusted hand on the scale points to zero before the unit is attached to the cow.

b. Be sure that all connecting hoses are long enough to permit free movement of the container.

c. Be sure that all connecting hoses are in the same position when you read the milk weights as they were when you made the zero reading.

d. See that the valves of the pipeline are turned so as to prevent any milk from one unit entering another during the first unit's emptying.

e. Take all weights before any milk is released. If the container will not hold all of the milk from one cow, drain the milk into a weigh pail and weigh it in the usual manner.

3. *Sampling.*—Proper sampling is essential to the conduct of the test.

a. After weighing the milk and before releasing any of it into the milkline, mix it thoroughly by opening a

sampling valve at the bottom of the container to let air bubble through the milk. To assure adequate mixing, continue air agitation for 1 second per pound of milk.

b. Mixing by other methods, such as shaking, rolling, and tipping, should be adequate to assure sufficient agitation.

c. Take the sample. The amount should be proportionate to production as explained in chapter IV, under "Sampling."

d. If the container will not hold all of the milk from one cow, drain all the milk into pails for mixing before taking a sample.

The Milk-O-Meter

The Milk-O-Meter is a metering device that is installed in the milkline from the cow to the pipeline for automatic weighing and sampling of the milk while the cow is being milked. The meter should be properly assembled before each milking. Holding clamps should be permanently installed for each location where the meter is to be used. Care should be taken to see that the clamps will hold the Milk-O-Meter firmly in a level position. The vacuum must be maintained at the proper level.

1. *Field test for accuracy.*—Check the Milk-O-Meter monthly for accuracy, as follows:

a. Place the Milk-O-Meter, without the Sampler but with the shell stopper in place, in a level position and on a solid base. A pipe clamp may be used or a vat edge stand adjusted to hold the meter level.

b. Connect a hose from a water tap to the upper spout.

c. Let 2 or 3 pounds of water run through the meter and then shut off the water.

d. Place an empty clean pail, previously weighed, under the meter to catch water so that none is spilled.

e. Set the dial pointer at zero.

f. Slowly open the water valve or tap until water is flowing through the meter at the rate of 4 pounds or 16 "clicks" per minute—NO FASTER.

g. Shut off the water when 17 pounds is registered on the meter dial.

h. Weigh the pail and water on a scale known to be accurate.

i. Deduct the weight of the pail and compare the net weight of water to the Milk-O-Meter dial reading.

j. With a meter reading of 17 pounds, a scale reading of 16½ to 17½ pounds is within accuracy requirements. If the reading is outside these limits, repeat the check.

k. If the same results are obtained on the second check, the meter probably needs to be recalibrated; it should be returned either to the factory or to an authorized service center.

2. *Weighing.*—The steps for weighing are as follows:

a. Before using the Milk-O-Meter and with the vacuum on, check the shaft attached to the pointer to see that it moves freely.

b. Set the pointer on zero before each cow is milked.

c. After milking is completed for each cow, reach behind the dial and trip the rocker shaft once before reading the weight. This allows for the small amount of milk that may be left in the meter when milking stops.

3. *Sampling.*—A small amount of milk accumulates in the sampling chamber during the milking process. After each cow is milked and the milk weight has been taken, remove the outlet cover of the sampling chamber while the vacuum is still on. This mixes the milk sample and removes the excess milk in the sampling chamber. Cut off the vacuum through the meter to let the milk drain into the sample jar.

Be sure all the milk has drained from the sampling chamber before the next cow is milked.

Other Methods

Check with your board of directors before using other weighing and sampling devices.

Care of Milk Samples

Keep each cow's milk sample in a clean, tightly closed, numbered milk-sample jar. The number of each sample jar might well be painted on the lid with enamel paint to insure greater permanence. The number should correspond with the sample number listed for the cow in the "sample" column on the barn-book sheet. Keep the sample jar in a locked box or case.

Do not test sour or frozen samples of milk. In freezing weather, keep the samples in a warm place. In extremely hot weather, keep the samples in a cool place or use a preservative. Corrosive sublimate or potassium dichromate tablets may be used according to the directions of the manufacturer, to keep the samples from souring. **CAUTION: Preservatives are very poisonous and must be kept away from children and animals. Milk samples that have been treated with preservatives and that are not used in making the test must be disposed of where children or animals cannot get to them.**

To insure reliable records and to prevent outside criticism, you must keep all milk samples, glassware, and any blank forms you carry under lock and key at all times except when you are actually using them.

Chapter V. Testing Milk

The Babcock test and the TeSa test are used for butterfat determinations in dairy herd improvement associations.

Testing Whole Milk by the Babcock Method

If your State regulatory agency has issued rules for conducting the Babcock test, follow them; otherwise, the test should be conducted as follows:

Heating the Centrifuge

Start the electric centrifuge heating, so that it will be at 135° to 150° F.

Tempering

1. If the test is to be run on fresh, individual milk samples, adjust the temperature of these samples to between 60° and 70° F. in a water bath just before mixing them and taking the pipetted sample for the test.
2. Place the jars holding the composite milk samples in a water bath with the surface of the water slightly above the level of the milk in the bottles.
3. The temperature of the bath should not exceed 100° F. at the time you place the cold samples in it. Composite samples and those with preservatives must be tempered to between 95° and 100° F. Do not shake or mix the milk in the sample jar until the milk has reached 90° F.
4. If any sample becomes diluted with water, discard it, and make a permanent record of the date of the accident and identity of the sample.

Mixing Before Pipetting

After the composite sample of milk reaches 95° to 100° F., mix it as follows:

1. Pour the sample into a mixing container and back into the original sample jar three times. Drain the mixing container for at least 15 seconds before using it again. Rotate the jar to loosen any cream; use a spatula if necessary. Be sure that cream does not stick to the cap or stopper. Overheating or rough shaking may cause the sample to *churn* and *oil off*.
2. Pipette the sample immediately after mixing.

Temperature of Milk for Pipetting

When you pipette the sample, the temperature of the milk should be between 90° and 100° F.

Pipetting

1. Rinse the pipette with milk before working with the first sample.
2. Place the tip of the pipette into about one-half the depth of the milk in the sample bottle. Fill the pipette and adjust the topmost surface of the milk to the graduated mark (17.6 ml.) on the suction tube. Insert the entire delivery tube of the pipette into the neck of the test bottle before releasing the milk. The lip of the test bottle should be vented, preferably with a grooved rubber gasket at the base of the bulb of the pipette.
3. When the pipette has drained for about 10 to 15 seconds after free flow has stopped, blow out the last drops or remove the pipette from the test bottle with a quick upward movement to force the last drops from the tip of the pipette. You will find it advantageous to use two pipettes alternately.
4. Cool the pipetted samples to between 60° and 70° F. before adding the acid.

Sulfuric Acid

1. Use sulfuric acid with a specific gravity of 1.82 to 1.825 at 68° F.
2. The acid should be between 60° and 70° F.—the same temperature as the milk.

Adding Acid to the Milk

1. The temperature of the milk at the time of adding the acid should not exceed 70° F.
2. Add 17.5 ml. of acid slowly to each sample. Hold the neck of the test bottle at an angle and rotate it as you pour, so the acid will flow down the sides of the bottle neck and wash all milk out of the neck.
3. Mix the sample with a smooth, rotary motion. Continue to shake for one-half minute after all curd has disappeared. The time of shaking is very important in obtaining accurate tests. Rough, delayed, or slow shaking will cause dirty fat columns. The same is true of too little or too much acid. If you are using a preservative in the milk, mixing for 3 minutes is recommended. Experienced supervisors can pour acid and then shake a tray of samples at one time. However, test bottles must be handled carefully to avoid charring before shaking is started. Properly handled, the mixed samples will have a dark chocolate color with no visible curd. An automatic shaker is an excellent timesaver.

Centrifuging

Transfer the test bottles immediately to a heated centrifuge. Bottles must be counterbalanced by having

the opposite cups filled. Use test bottles filled with water or with duplicate tests if necessary.

1. Centrifuge at full speed for 5 minutes.
2. Add water (150° F. or above) to within one-fourth inch of the base of the neck of the test bottle.
3. Centrifuge again for 2 minutes.
4. Add water to bring the fat within the graduated space in the neck of the test bottle. *Do not overfill.*
5. Centrifuge again for 1 minute.
6. Use water, free from oil. To soften hard water, add about two drops of sulfuric acid to each quart of water. *Never* add water to acid.

Water Bath

Transfer the test bottles immediately to a water bath at 135° to 140° F. Temper for 5 minutes. Be sure that the water is above the top meniscus of the fat columns. (The meniscus is the saucer-shaped surface at the ends of the fat column. The bottom of the meniscus is the bottom of the saucer, and the top of the meniscus is the outer rim of the saucer.)

Reading Tests

1. Be sure that the entire fat column is within the graduations on the neck of the test bottle.
2. Remove each test bottle separately from the bath; hold it perpendicularly in front of a diffused light; and measure with a measuring device the length of the fat column from the bottom of the lower meniscus to the top of the upper meniscus.
3. Measure the fat column on the ungraduated side of the neck and read the test from the graduated scale.
4. Read the fat test to the nearest 0.1 percent.
5. Do not read the test if the fat column is foamy, burnt, or curdy, or if the meniscus is irregular. If such tests are used, inaccurate results will be obtained.
6. Do not empty the sample jars until all tests have been verified and recorded. Rerun all questionable tests. All tests that are abnormally high or low in relation to breed, stage of lactation, or previous records on the cow or herd should be verified by duplicate tests of samples involved.

Defective Tests

A test is considered defective and inaccurate if the fat column is milky or indistinct, or if flakes of casein or charred material are in or below the fat column, and you should repeat the test. The following information should be helpful in correcting procedures that result in defective tests.

Dark-Colored Fat Column

A dark-colored or burned fat column containing dark particles near the lower meniscus is usually caused by improper mixing or by one of the following:

1. The acid was too strong.
2. Too much acid was used.
3. The acid was too warm when it was added to the milk (over 70° F.).
4. The milk was too warm when the acid was added (over 70° F.).
5. The acid was dropped directly into the milk. (The test bottle should be tilted so the acid will flow down the sides.)
6. The mixing was interrupted before the solution was complete.
7. The acid and the milk stood too long before being mixed.
8. The action of the acid was too fast because of failure to use rotary motion in mixing milk and acid.

Light-Colored Fat Column

A light-colored fat column containing white curdy material or sediment near the lower meniscus may be caused by one or more of the following:

1. The acid was too weak.
2. Too little acid was used.
3. The acid was too cold when it was added to the milk (under 50° F.).
4. The milk was too cold when the acid was added (under 50° F.).
5. The mixing was not continued long enough to dissolve all the milk solids.
6. The centrifuge was operated too slowly.

Foam on Fat Column

Foam appearing on the top of the fat column in the test bottles, obliterating the upper meniscus, usually is caused by the use of hard water containing carbonates. You can usually remove the carbonates from the water before it is used by adding a few drops of sulfuric acid to the water and stirring vigorously to insure that the chemical reaction is completed. Never add water to acid.

The TeSa Test

Preparing TeSa Reagent for Butterfat Determination of Raw Milk

TeSa reagent solution.—Dissolve TeSa reagent concentrate powder in any clean water. The 40-test package makes 500 ml., or 1 pint of solution. The 160-test package makes 2,000 ml., or 2 quarts of solution. To avoid loss due to foaming, the powder should be added slowly to about two-thirds of the total water required. After the reaction has subsided, add water to make the total volume required. MIX AT LEAST 6 HOURS BEFORE USE.

Milk Test Reagent

To prepare TeSa milk test reagent, add one part of methanol or commercial grade wood alcohol to five parts of TeSa reagent solution. The solution *MUST* have been mixed at least *6* hours. Milk test reagent may be used as soon as prepared. Use milk test reagent for testing fresh or preserved raw milk.

General Precautions

TeSa TEST REAGENT SOLUTION SHOULD NOT BE USED MORE THAN 2 WEEKS AFTER THE SOLUTION IS PREPARED. MILK TEST REAGENT CONTAINING ALCOHOL SHOULD NOT BE USED MORE THAN 3 DAYS AFTER PREPARATION.

It is important that the time in the boiling bath be at full temperature. Begin timing when vigorous boiling resumes.

IN READING ALL TESTS BY THE TeSa METHOD, READ THE TRUE LENGTH OF THE FAT COLUMN—FROM THE BOTTOM OF THE UPPER MENISCUS TO THE BOTTOM OF THE LOWER MENISCUS.

NOTE.—Boiling time for preserved samples is 15 minutes; for other milk, 10 minutes.

Mercuric chloride (corrosive sublimate), sodium dichromate, potassium dichromate, or formalin (37 percent formaldehyde solution) may be used as preservatives. Use the minimum amount of preservative necessary for the sample size and holding time.

Testing Raw, Unpreserved Milk

1. Pipette or measure 17.6 ml. of a well-mixed sample at 59° to 68° F. into the side arm tube of a TeSa milk test bottle.
2. Add 15 ml. of TeSa milk test reagent through the side arm of the TeSa bottle and mix at once with a swirling motion to uniform color.
3. Place in a boiling water bath deep enough to cover the liquid level in the test bottles. Allow the test bottles to remain in the bath at least 10 minutes after active boiling resumes.
4. Remove the bottles from the boiling bath and place them on a table at room temperature. Add hot water through the side arm tube of each TeSa bottle until liquid entirely fills the lower bulb of the test bottle. Then go back over the tray of bottles and add hot, clean water to bring the top of the fat column to near zero on the reading scale. Allow bottles to stand at room temperature for 5 minutes. Do *not* use water from the boiling bath.
5. Transfer the bottles to a tempering bath (132° to 140°F.) deep enough to cover the fat column in the neck of the bottle. Just before placing the tray of bottles in the tempering bath, agitate with a rotary motion.
6. After tempering for 3 minutes, remove the bottles from the bath and immediately read the fat percentage indicated in the center of the column. Read from the BOTTOM of the upper meniscus to the BOTTOM of the lower meniscus.

Testing Composite Preserved Samples of Milk

Use the same procedure as for raw, unpreserved milk—EXCEPT for item 3. Boil for 15 minutes, instead of 10 minutes.

Test for Protein and Solids-Not-Fat

In some States, milk is being tested for protein and for solids-not-fat. If yours is one of these States, your board of directors or the State extension dairyman will give you material outlining the procedures to be used. Include this material as a part of the handbook.

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Chapter VI. Interpreting the Testing Period

Testing Date

The testing date is the date you finish the test on a farm. If you arrive at the farm in the afternoon of the 19th of the month, the day you leave—the 20th of the month—is the testing date. If it takes 2 days to test the herd, and you leave the farm on the 21st of the month, the 21st is the testing date.

Enter the testing date (month, day, and year) in the space or spaces provided in the heading of the barn sheet.

Centering Date

Most cows decline in production as their lactation progresses. Therefore, they must be tested approximately in the middle of each month in order to get an accurate estimate of their production for that month on a calendar-month basis. Since all herds cannot be tested in the middle of each calendar month, a monthly testing period is established for each herd. To do this, a centering date is assigned to each herd the first month it is tested. Usually the date on which you test the herd the first month becomes the established centering date for the herd. The monthly testing period begins 15 days before the centering date and ends 12 to 15 days after the centering date, depending on the number of days in the month. Thus, the centering date always falls about the middle of the testing period. In assigning centering dates you must consider your route and the location of the herd in relation to other herds in the circuit.

Once you have established a centering date for a herd, it remains the same month after month even though you do not test the herd on exactly this date each month. You should vary your visits to each farm so that succeeding testing dates will fall in a period 3 days before to 3 days after the established centering date. This is to insure that the dairyman will not know the exact date of your arrival and that the time of milking and feeding procedures will be the same as though you had not come that day. Weighing and sampling the milk will, of course, cause some delay in the milking, but this is unavoidable. Unless you change your route, the herd will have the same centering date year after year. If you assume your duties in an association already in operation, use the centering date previously established for each herd. In a new association without a full membership at the time testing is started, leave several "open" centering dates in your schedule for new members who join the association at a later date.

Give large herds that cannot be tested in 1 day only one centering date for the entire herd. If it takes 2 days to test the herd, the second day is the centering date; if it takes more than 2 days, the day near the middle of the test is the centering date. The local DHIA board of directors and the State extension dairyman determine the number of cows to be tested daily. Generally, a supervisor should not work with more cows daily than he can complete work with in 1 day (appendix, DHIA rule 7).

Enter the same established centering date for the herd each month in the space provided on the heading of the barn sheet.

New Herds Coming Into Association During Testing Year

Frequently a new herd coming into an association during the year is located so that, to avoid unnecessary travel, you should test the herd at a time in the month in which all the centering dates have been assigned. However, since you have a range of 7 days (3 days before and 3 days after the centering date) in which to test a herd, you usually can assign a centering date to a new herd even though it may result in two herds in the same association having the same centering date. When too many herds have the same centering date, you may reassign the centering date for the various herds. When this is necessary, you must make certain calculations or report the situation to your computing center for their special attention in order to adjust the cows' records for the resulting "overlap" or "gap." Your computing center will give you instructions on how to handle this situation.

Monthly Testing Period

To report records correctly, you must understand and remember that you are reporting production and feed records for a testing period, not for a calender month or months, and that the testing period for each herd varies with each centering date.

After the centering date is established for a herd, you can easily determine the testing period for each monthly test by referring to the monthly table (appendix table 1). (If the association operates on the bimonthly testing plan, use appendix table 2 to determine the inclusive dates of, and the number of days in, the bimonthly testing period.)

Each month, after you have entered the established centering date for the herd on the barn sheet, refer to the appropriate table to obtain the inclusive dates for the corresponding testing period. Enter the correct dates (month, day, and year) in the space provided in the heading of the barn sheet if your center requires them.

You will refer to the inclusive dates of a testing period many times even though you do not normally calculate records by hand. With the dates in this

handbook, it will not be difficult to calculate the correct number of days for cows in milk or cows coming into or leaving the milking herd during the testing period when you are required to make corrections.

Days in Testing Period

If the association operates on the monthly testing plan, the number of days in the testing period is the same as the number of days in the calender month in which the centering date falls. (If the association operates on the bimonthly testing plan, the number of days in the testing period is the number of days in the month in which the centering date falls plus the number of days in the preceding month.) However, it is not necessary for you to calculate the number of days in the testing period because this information is given in appendix tables 1 and 2. You should always refer to these tables rather than trust your memory as to the number of days in the various testing periods.

Chapter VII. Reporting Data for the Testing Period and Special Situations

Reporting data on production, feeding, and income of the dairy herd varies among the computing centers. This is necessary and desirable for several reasons. One reason is the difference in the characteristics of dairy-farm operations in the various areas of the United States. Another reason is the difference in the kind and completeness of the records kept in the various States. A third reason is the variation in capacity of the several types of computers now in use. The purpose of this chapter, therefore, is to enumerate the items of the monthly report included on forms from one or more of the computing centers that you need to check to insure a complete report of data from the herds you test, to emphasize proper and legible reporting, and to list some special situations which will require instructions from your computing center. Each center will need to issue detailed instructions for reporting data on the forms it uses.

Report Full Herd Code

In order to handle and process individual dairy production records in volume and to satisfactorily identify the herd in which the record was made, each herd must have a herd code number.

A uniform herd code numbering plan has been developed that will accurately *identify each herd* and at the same time *indicate the type of record* being kept in the herd.

The herd code number consists of eight digits. The fifth digit indicates the type of plan—Standard, Owner-Sampler, Weigh-a-Day-a-Month, DHIR. Examples follow:

1. For Standard Dairy-Herd-Improvement-Association records, the herd code is as follows: 27–01–0001. This number indicates the following:

State No.	County No.	Standard No.	Herd no. within county
27	01	0	001

If the first digit after the county number (the fifth digit) is 0 through 6, the herd is on Standard plan recordkeeping. See item 2 below for use of 6 as the first digit after county number.

NOTE:—Herd codes *now* assigned to Standard herds *can continue* to be used by simply placing a "zero" in front of the present three-digit number now used to indicate the herd within the county.

2. The only time 6 is used as the first number after the county number in a Standard herd code is when a herd is one of several owned by the same owner. If a herd is to be divided into several herds, the last three numbers can be in whatever sequence is determined in the county, but the first digit after the county number should be 6 for every herd. An example follows:

State No.	County No.	Standard No. (1 of several herds of same owner)	Herd No. within county
27	01	6	001
27	01	6	024
27	01	6	025

The herds in this example were managed as one herd, No. 27010001 for some time, then were divided into three herds after herd codes 27010002 through 27010023 had been assigned in the county.

3. For Owner-Sampler records, the herd code would be as follows: 27–01–7001. This number indicates the following:

State No.	County No.	Owner-Sampler No.	Herd No. within county
27	01	7	001

The first digit after the county number, 7, indicates Owner-Sampler recordkeeping.

4. For Weigh-a-Day-a-Month records, the herd code number would be 27–01–8001. This number indicates the following:

State No.	County No.	Weigh-a-Day-a-Month No.	Herd No. within county
27	01	8	001

The first digit after the county number, 8, indicates Weigh-a-Day-a-Month recordkeeping.

5. For herds on DHIR test, a State may elect to use the following system: The first digit after the county number will be changed from the original number to 9. For example, if a herd with a code number 27–01–0001 begins DHIR testing, its number would change to 27–01–9001.

Assignment of Herd Codes

1. *By the State extension dairyman.*—Herd codes both for herds on Standard DHIA test and for herds on test in Owner-Sampler testing *should be assigned by the State extension dairyman.* At the time the State extension dairyman assigns the herd codes, it is suggested that he should (1) set up a *ledger record* in which to list by county, by herd code numbers, in

numerical order, the name and address of the dairymen, thereby eliminating any possibility of assigning a herd code to more than one herd; and (2) fill out the *file card* (DHIA 1108) listing the name of the dairyman, his mailing address, and herd code number for filing in alphabetical order.

These two files—the ledger record and the card record—will provide cross-reference files so that the herd code record may be readily referred to either by number or by the name of the dairyman.

Herd codes must *never be reassigned* if identification of herds in which the records are made is to be maintained. Example: John Doe is assigned herd code 27–02–0020. As long as John Doe is a member of a Standard DHIA, his herd records and his cows' 305-day lactation records are reported and placed on file carrying his herd code number, 27–02–0020. Should John Doe drop out of DHIA, his code number must be dropped and never reassigned to a new member. Thus, as long as records from John Doe's herd are on permanent file, they will be definitely identified as having been made in Herd 27–02–0020.

2. *By the county agricultural agent.*—It is suggested that the Weigh-a-Day-a-Month herd codes be assigned and recorded by the office of the county agricultural agent. The office of the State extension dairyman would assign each county the first *five* digits of the herd code number to be used in each county.

State No.	County No.	Weigh-a-Day-a-Month No.	Herd No. within county
27	01	8	001
To be assigned by State office			To be assigned by county office

The county office would assign the last *three* digits for each herd code. It is suggested that, in the county, a simple *ledger record* of herd codes be established to record in numerical order all herd codes assigned. NO HERD CODE MUST EVER BE REASSIGNED TO ANOTHER HERD.

Price and Value of Product

Many pricing formulas are used over the United States. Use the method used by the dairyman or recommended by your local board of directors. Generally, the price reported should be the plant price. Examples of some pricing formulas follow:

Whole Milk

If whole milk is sold according to butterfat content, determine the price on the basis of the average price received for whole milk.

If milk is sold at both base and surplus prices, calculate the average price as follows: Suppose 20 percent of the milk is sold at a surplus price of $3 per 100 pounds, and the remaining 80 percent is sold at a base price of $4.50 per 100 pounds. The average price is ($3×0.20) + ($4.50×0.80), or $4.20. Report this price.

If whole milk is sold by the gallon or quart, convert the gallon or quart price to price per hundred pounds. This is done by dividing the price per gallon by the pounds of milk per gallon (8.6) and multiplying that answer by 100.

When milk is bottled and sold to the retail trade at a price competitive with milk sold in stores, report about 50 percent of the selling price. Disregard the remaining 50 percent of the retail price, which is considered cost of delivery. These percentages vary, depending on the price of whole milk at the dairy plant. Use whatever percentages apply in your area.

Butterfat and Skim Milk

When milk is separated on the farm, and the cream and skim milk are sold separately, report the hundredweight price of milk as the sum of prices for butterfat and skim milk in the hundred pounds.

Usually, however, when milk is separated, only the cream is sold, and the skim milk is fed on the farm. The value of the skim milk must be included in the total value of the product, or the cows will not receive full credit for the product. Consult your board of directors if the dairyman cannot give you details of pricing butterfat and skim milk.

Protein and Solids-Not-Fat

If your association prices milk on the protein or SNF basis, obtain instructions from the dairyman or your board of directors for determining these values.

Report Correct Identification Numbers

In reporting identification numbers, take great care to be sure that you do not omit or transpose digits in copying numbers. Also, be sure that you are reporting the correct number, not the number of the dam or sire of the cow whose record you are reporting. In reporting DHIA, AI, or disease-control eartag numbers, report the entire number, including the prefix, as 51–WAA–7814. Do not omit the "51" or the letters "WAA."

Check each report after you have it ready to mail, to be certain that the information on the report is exactly as it is recorded in the herd-record book.

Breed Codes

1—Ayrshire
2—Guernsey
3—Holstein
4—Jersey
5—Brown Swiss
6—Milking Shorthorn
7—Red Dane
8—Mixed, Other, or Unknown
9—Red Poll

A herd should be coded as a particular breed if 75 percent or more of the cows are of that breed. If at least 75 percent of the cows in the herd don't belong to one of the breeds listed above, the herd should be coded "8" for breed.

Reporting Days on Test, Days in Milk, and Days Dry

Each cow must be credited with the correct number of days on test, in milk, and dry in each testing period if her production and feed records are to be correct for the testing period, for the year, and for her lactation period. Cows not in milk every day of the testing period are those that freshened, dried off, aborted, died, were purchased, or were sold during the period. Under DHIA testing, heifers are not considered a part of the herd until the fourth day after calving, counting the calving day as the first day. Be sure to follow

your computing center's instructions for reporting this information.

Report Correct Dates

Errors in reporting dates occur frequently. Check the herd-record book carefully to be sure you have not reported one date for another—for example, a breeding date for a freshening date, or vice versa. After you have recorded the dates on the report form, check to be certain that you have not confused the various dates and that you have copied them correctly.

Remarks

If the form has a column or space headed "Remarks," enter in this space important notes and data for which no other space is allotted and which the center must have to compute records. This space can also be used to enter eartag numbers of calves or other information useful to the dairyman.

Reports Must Be Complete, Accurate, and Neat

Read this section frequently. The seriousness of reporting incomplete or inaccurate data cannot be overemphasized. Not only are incomplete and inaccurate reports worthless, but also they may actually be harmful. Inaccurate data will result in an inaccurate evaluation of a sire, or false conclusions from herd data. The following tabulation shows the effect of certain errors in reporting feed amounts and quality on Concentrates Indicated, one of the columns used by some computing centers.

Errors in reporting—	*Effect on concentrates indicated (pounds)*
Hay (2 pounds)	1.
Silage (5 pounds)	1.
Forage quality (1 grade)	2 or more.
Forage dry matter (2 percent)	1.
Body weight at calving (100 pounds)	1–2.

Observe the following precautions to avoid making errors in reporting data:

Write Figures Plainly

1. Write digits 2, 3, 5, 6, 8, 9, and 0 plainly by forming the circular parts so that there is plenty of open space in the enclosed or partly enclosed space of the digits. Also, see that the circular portions of 6, 8, and 9 are completely enclosed, but that the circular portions of 2, 3, and 5 are left open. When the circular portion of a 5 is closed or nearly closed, it often resembles a 6.

2. Leave the 4's open so that they will not look like 9's, and close the 9's so that they will not look like 4's.

3. Make the digit "one" as a straight line (1) without any "tick" at the top of the line. Many times the "tick" of a 1 is large enough to look like the bar at the top of the 7. Similarly, make 7 distinct so it will not look like 1.

4. Write figures so plainly that anyone not familiar with your writing can read the numbers correctly.

Write Names Plainly

1. Write or print names and addresses of herd owners so plainly that anyone not familiar with your writing can read and spell them correctly.

2. Make all letters distinct—take care to make the first letter of names especially plain. Print capital letters like S and L, M and W, or A, C, and O so that no one will confuse one letter with another.

3. Write small letters plainly. Letters like g, y, and z; h and k; m, n, and r; u and v are easily confused unless they are written carefully. Unless the i's are dotted and the e's are looped, these two letters are also easily confused. Loop the l's and cross the t's so that one letter will not be confused with the other.

4. If your handwriting is not plain, print the names and addresses of herd owners.

5. Include the herd identification number on all reports, and write the herd-owner's name exactly as it appears on the title page of the herd record book.

Special Situations

Special situations that require instructions from the computing center are as follows:

1. Lost milk.
2. Lost samples.
3. Sick or injured cows.
4. Abnormal tests.
5. Failure to obtain milk weights or samples, or both, on any cows in the last month of an association year when the herd is not going to be on test again.
6. Change of centering date.
7. Nurse cows.
8. Aborting cows or other cows freshening without going dry.

Retests—Owner's Request

If for any reason a herd owner is not satisfied with the test on his herd, he may call for a retest. You may stay on the farm another day to run the retest. If the owner prefers another supervisor, he should notify his board of directors, and a retest may be arranged as soon as another supervisor is available. The herd owner will be required to pay for the retest unless otherwise determined by the local board of directors. All cows tested on the first test must be included in the retest. "The use of the requested retest and the regular test shall be at the discretion of the State extension dairyman" (appendix, DHIA rule 16).

Surprise Test—DHIA

Surprise tests may be conducted on Standard herds for verification of records of high-producing cows and herds and for investigation of rule infractions. They may be ordered by the State or local organization and/or the State extension dairyman.

The use of the surprise test and the payment thereof shall be determined by the organization requiring such tests. Surprise tests shall be preceded by a preliminary dry milking.

Surprise Test—DHIR

For information on how to conduct surprise tests for herds on DHIR, see appendix, DHIR rule 18.

Chapter VIII. Calculating Records

Even though records are calculated at a computing center, the supervisor may be required to make some of the same calculations that are necessary for hand-calculated records. This chapter is included to aid the supervisor in making these calculations.

Milk Weights for the Current Testing Period

To obtain the total for milk, multiply the daily total by the number of days the cow was in milk during the testing period. Round according to instructions from your computing center.

Butterfat for the Current Testing Period

After you have found the percentage of butterfat for each milk sample, multiply the total pounds of milk produced during the testing period by the percentage of butterfat to obtain the butterfat produced during the period. Round to the nearest whole pound.

Protein and Solids-Not-Fat

After the percentage of protein or SNF, or both, has been determined, calculate the total pounds for the testing period in the same way as for butterfat.

Fresh Cows

The record of a fresh cow begins on the fourth day after calving, counting the calving day as the first day, but her milk is not tested earlier than the seventh day after calving, counting the calving day as the first day. For example, if a cow freshens on the 21st of the month, her record begins on the 24th, but do not test her milk before the 27th. You can take the first milk weights and samples on the evening of the sixth day after calving—in this example, on the evening of the 26th.

If a cow has not been fresh 6 days before the testing date, do not report her fresh or calculate her production for that testing period until your next visit to the farm. To complete her record and bring it up to date, use the weight and test you obtain for her second month of production to calculate her production for the previous testing period. This is known as giving "back credit."

First-calf heifers are started on test on the fourth day after calving, counting the calving day as the first day. A first-calf heifer would be on test and in milk the same number of days in the first testing period, and her production and feed records would be calculated for only the number of days in the testing period since her record began.

Purchased Cows or Herds Started on Test

If a purchased cow enters a herd and has calved within 90 days of the current testing period, all her production may be credited to her. The same is true of cows in a herd just starting the testing program. Purchased cows with DHIA records in progress should have their production to the date they entered the herd transferred to the computing center so that the record can be completed. Purchased cows that have not been in a recordkeeping program and that have been fresh not more than 90 days at the end of the current testing period get production credit from the date they enter the herd.

You will need to get instructions from your computing center for handling this situation.

Dry Cows

Charge cows that are dry on the testing date, but were in milk for some of the testing period, for feed consumed for the full testing period, but give them production credit for only the number of days they were actually in milk from the beginning of the testing period up to and including the last day milked. Since you cannot obtain milk weights and samples during the current testing period, calculate the cow's production credit on the basis of daily weights and tests obtained the previous month. This procedure is often referred to as calculating "forward" credit from a previous test. (See appendix table 5.)

Cows Sold and Cows Died

If a cow in milk is sold during the testing period, give her production credit and charge her for feed consumed for the actual number of days she was in the herd within the inclusive dates of the testing period. Include her production on the day she leaves the herd.

If a cow is sold before the testing date, calculate her production and feed records for the number of days she was in the herd on the basis of the daily weight and test you obtained the previous month.

Calculate feed and production records for cows that die during a testing period in the same way as for cows sold. (See appendix table 5 for calculations for both situations.)

Aborting Cows

Aborting cows are not tested until the seventh day after aborting. If a cow aborts while dry, calculate her record in the same way as for a fresh cow.

If a cow aborts while in milk after carrying a calf 152 days, her current record ends and a new lactation begins. Calculate her production for that part of the testing

period before the abortion on the basis of her last test before the abortion. Allow a lapse of 3 days, and calculate her production for the remainder of the testing period on the basis of her first test after this 3-day period. Note these facts in the "Remarks" column on the barn sheet and on the cow's individual record sheet.

If the cow that aborts while in milk cannot be tested on the testing date, credit her on the barn sheet for production to the day she aborts, based on her previous test, and consider her dry for the remainder of the testing period. On the next testing date, give her "back" credit for production that should be included in the testing period in which she aborted.

If a cow aborts after the testing date but before the end of the testing period, you have already reported her production for the period. When you record her production for the next testing period, report this situation as a correction to the computing center.

Cows Freshening Without Going Dry

If a cow freshens without going dry, calculate her production record in the same way as for a cow that aborts while in milk.

305-Day Lactation Records

Appendix figure 2, "Supervisor's Work Sheet for Calculating Lactation Records," shows how to calculate 305-day lactation records.

Changing the Centering Date

When it is necessary to change the centering date for a herd, an adjustment will be required for the production of each cow in milk. Ask your computing center for instructions on calculating the adjustment in production.

Calculate Records Correctly

A study of errors made by supervisors in reporting 305-day lactation records revealed the following types of errors:

1. *Incorrect number of days in lactation.*—This error usually occurs in the first monthly testing period after a cow freshens. Many supervisors give the fresh cow credit for the total number of days in the first monthly testing period. Usually this is incorrect. Give the fresh cow production credit for only the actual number of days she is in milk during the first testing period. This can be done easily by following the procedure in the Year-Day Table (appendix table 6) for calculating days in milk. Similarly, when a cow goes dry, give her production credit only for the number of days she is in milk during the last testing period of her lactation. Follow carefully the procedure outlined under "Dry Cows" earlier in this chapter and use the Year-Day Table for calculating "Days Dry" (appendix table 6).

2. *Errors in addition.*—Most errors in addition are due to carelessness. Record or aline the data so the columns of digits cannot be confused. Many errors occur because the supervisor drops or adds a digit, or switches from one column to another in adding. Always check your addition.

3. *Errors in calculation.*—Errors also occur in calculating the data for "Production Since Last Fresh."

Chapter IX. Feed Reports

Naming Feeds

Report definite names or codes of succulent and dry forages, individual grains, and feed supplements. Green chop may be included either as pasture or as succulent forage. Follow your computing center's instructions as to how to report green chop. If a home mixture of grains and supplements is fed, record it as "Home Mix" and give the percentage of total (crude) protein. If a commercial mixture is fed, record it as "Com. Mix" and give the percentage of total (crude) protein. Only one figure for amount fed should be reported for each class of feed, unless your computing center gives you different instructions.

Weigh or measure carefully the amount of grain and concentrates fed each cow on the testing date to determine accurately the amount each cow consumes daily. The amount consumed is the amount fed minus the feed refused. Record the amount consumed daily (to the nearest pound) in the space provided.

Forage

The amount of succulent and dry forage consumed by individual cows in the herd is difficult to determine. If it is impractical to obtain actual weights of forage fed to individual cows, first determine the total amount consumed (total fed minus any refused during the 24 hours covered by the testing day) by the herd, and then either divide this uniformly among all the cows or prorate it according to the weight of the individual cows.

By checking closely with the dairyman, you usually can determine with reasonable accuracy the total amount of forage consumed by the herd. Hay often is baled. Multiply the number of bales fed daily by the average weight of the bales to obtain the total daily weight of hay fed. In the same way, multiply the number of baskets, carts, or carriers of succulent forage fed daily by the average weight of the baskets, etc., to obtain the total daily weight of the forage. If succulent forage is fed from a wagon, trailer, or truck, figure 20 pounds per cubic foot. The amount of forage refused by the cows should be subtracted from the amount fed in order to obtain forage consumed, which is the figure to report.

Always indicate forage quality according to the quality codes issued for your area by your computing center or the State extension dairyman. For determining quality of succulent forage, the use of a field moisture tester is strongly urged. This equipment will aid greatly in determining quality of forage.

Price and Cost of Feed

Follow the instructions of your computing center for reporting prices of feed fed to the dairy herd.

Suggested Amounts of Grain To Feed

If the barn sheet has a "Concentrates Indicated" column, discuss the amount given each month with the dairyman. Accurate reporting of feed fed and forage quality is essential if the figures in this column are to be of any use to the dairyman. If the feed reported is accurate, the concentrates indicated should have real meaning. If the barn sheet does not include this information, it can and should be discussed with the dairyman anyway. You can recommend grain feeding according to the production of the cows. The dairyman should vary the recommended weights of grain to fit special cases, such as cows that are in poor condition, cows that are gaining weight, and cows that are off feed.

Estimating the Weight of a Cow

A dairyman must know how much his cows weigh if he is to feed each cow according to her maintenance and production requirements. The computing center also needs this information to figure the indicated concentrates, the feeding index, and the rate of forage feeding.

Use the special measuring tape, which is a part of your supervisor's testing equipment, to estimate the weight of a cow by her heart-girth measurement.

To take the heart-girth measurement, place the tape directly back of the cow's front legs. The cow should be standing squarely on all four legs. Draw the tape snug. Then read the estimated weight direct from the tape.

Estimate the weight of the cow the first month she is fresh, and record her weight in the space provided on the barn sheet and on her individual record form. Estimate the weight of purchased cows the first month they are tested.

Chapter X. Identification Records

Improvement of the Nation's dairy cattle through breeding is one of the important objectives of the DHIA program. A progressive breeding program is possible, however, only when each cow and her sire and dam are properly identified and production tested.

The DHIA breeding program is not confined to herds or associations within a State. Family lines of dairy cattle frequently extend to herds widely scattered in different associations or in different States. With the identification record of each animal established and recorded in the dairyman's herd-record book so that it can be reported accurately when production records are reported, the production records can be used to locate animals (both male and female) and families of animals that possess and transmit inheritance for high producing capacity. Such animals may then be used as breeding stock to spread the improved hereditary influence they possess throughout the dairy population.

Identification and Production Records

Every dairy animal in a DHIA herd must be positively identified and have her identification recorded in the dairyman's herd-record book within 60 days after the animal enters the herd by birth or purchase. Acceptable identification shall be (1) a registration number, or (2) a uniform-series eartag as used in DHIA, disease eradication, and artificial breeding (State code, three-letter prefix, four digits). Cows born before January 1, 1957, that have the old-series eartag numbers will continue to use them.

Tattoo numbers, branded numbers, or private eartags are not acceptable forms of identification by themselves, but they can be used for on-the-farm identification if the animals also have a registration number or a uniform-series eartag. (See appendix, DHIA rule 3, for more complete information about eartagging.)

Establishing Identity

Identity is not established until a record of the identification is made.

DHIA Eartags

A special DHIA eartag is used. The tag has a sealing device that makes removal of the tag very difficult, if it is inserted properly. One side of the tag bears the name of the State and the letters "D.H.I.A." On the other side of the tag is one of the uniform-series numbers.

The manufacturer supplies each State with eartags, using a numbering plan in each State that is a part of the national numbering plan. This plan avoids duplication of numbers in any State or between States.

In some States, the State extension dairyman distributes the eartags to supervisors and keeps a complete record of the serial numbers of all tags distributed to each supervisor. In other States, this is handled by a State regulatory agency.

Animals To Be Eartagged

You must give all unidentified animals a DHIA eartag. All milking animals that carried a temporary identification as heifers must be registered or retagged with an acceptable identification.

When all the animals in a herd have been either eartagged or registered and their identification numbers have been recorded, only newborn stock and purchased replacements will need to be eartagged and recorded to keep the entire herd identified.

The Supervisor Is Responsible for the Eartag

All calves should be eartagged as soon as possible after they are born. Sometimes you will give a dairyman a group of eartags so that he may eartag all young stock and all replacements not registered or eartagged that are born or that otherwise enter the herd between your visits. However, you are reponsible for the eartagging of all association animals, and you must account for every tag in the identification record.

Affixing an eartag is a simple process, but it should be done methodically and with great care. You or the dairyman should take the necessary time to affix the tag properly and securely. Use special pliers to affix the tag. The pliers cause the prong of the tag to pierce the ear and expand within the sealing button, in one operation.

Seat the eartag properly in the jaws of the pliers so that it is held securely. The button side of the tag, bearing the name of the State and the letters, D.H.I.A., must lie flat and snug in the grooves of the jaw of the pliers. In this position the pronged side of the tag bearing the identification number *will not* lie flat against the other jaw of the pliers. If seated in this manner, the tag is held securely and will not move sideways in the pliers.

You must tie the animal securely so that it cannot move its head. It is not enough simply to have the animal in a stanchion. If the animal is able to move its head even slightly, the prong may be bent or the tag shifted in the pliers so that it will not seal properly.

Place the tag in the *top* of the *right* ear about one-third the distance from the head with the *numbered side of the tag on the outside of the right ear.* In this position the tag is secure and may be read easily. Avoid placing the tag in the curvature near the base

of the ear, as this may result in irritation and possible loss of the tag. In a mature animal, place the tag so that the curved end will be flush with the edge of the ear. On young stock place the tag so as to allow approximately one-fourth inch for growth of the ear. After the tag has pierced the ear, you must apply strong pressure to the handles of the pliers to insure that it is clinched and sealed securely. If you take these precautions, few tags will be lost.

Lost Tags

If you affix eartags properly, very few will be lost. But if an animal does lose an eartag, you should affix a new one on your next visit to the farm. When you retag an animal, the original number remains her reporting number. The new number is recorded with the old number in the herd-record book to keep it up to date, but the new number is used *only* for on-the-farm identification. Follow the instructions of your computing center when retagging any animal.

Recording Identification Data

The most important part of identifying animals with eartags is the record of that identification. Merely eartagging an animal is not in itself sufficient. To complete the identification, you must make a record of the eartag number together with the identification number of the sire and dam of the animal.

Record in the herd-record book the identification of every animal in the herd that is registered or is eartagged (including the identification numbers of the sire and dam).

Chapter XI. Herd Improvement Through Breeding

Genetic improvement in herd performance is realized through the recognition and use of superior sires and cows. The use of sires of known genetic superiority is the most effective single method because one bull may leave many progeny; selection among cows is limited because of such losses as injuries, mastitis, and breeding failure. Consequently, major emphasis should be placed on recognition and use of genetically superior bulls.

Sires are now being evaluated by the method of herdmate or contemporary comparisons in the National Cooperative Dairy Herd Improvement and Sire Evaluation Program. The basic principle of the herdmate comparison is that a sire can be evaluated by comparing the production of his daughters to the production of other sire progeny groups that were fed and managed under the same conditions. This method is superior to the previously used daughter-dam comparison because it minimizes the importance of production differences from year to year and from herd to herd. The reliability of the herdmate comparison method is further increased by adjusting for the following factors for each sire: (1) the number of herdmates each daughter has, (2) the number of daughters of the sire, and (3) genetic differences between herds.

The USDA–DHIA sire evaluation program provides sire summaries representing DHIA and DHIR herds on a quarterly basis. Each sire having five or more production-tested progeny with production-tested herdmates qualifies for summary. Individual sire records are made available to the Extension specialists in charge of testing in each State in which a sire's progeny is represented, as well as to the appropriate national breed association office and, in the case of bulls used in artificial insemination (AI), to the appropriate AI organization. Bound copies representing summaries of all sires evaluated are distributed in a similar manner.

Artificial Insemination

In AI, sires are normally used in many herds and, consequently, under varying feeding and management conditions. Under these conditions, sires having production-tested progeny and herdmates in more than 20 herds can be appraised and their future performance accurately predicted. Consequently, the USDA–DHIA sire evaluation program provides "predicted averages" for sires in AI and is especially useful in comparing these sires, which have been used in a wide variety of herd conditions.

Naturally, it is not possible to predict *exactly* how a sire will perform in a particular herd. However, bulls which sire daughters that produce well above their herdmates in one herd will do the same in other herds. This general superiority will be evident at all levels, but will be slightly less in high-producing herds than in low-producing herds. The dairyman can use the average difference between daughters and herdmates as a guide in predicting how the daughters of a particular bull may perform in his own herd.

Natural Service

Evaluation of sires used under natural service conditions differs from evaluation of sires used in AI in that the former are normally tested and used in a single herd or in a relatively few herds. Bulls used in natural service are also evaluated in the USDA–DHIA sire evaluation program by contemporary herdmate comparisons and the information is made available as previously described. Unfortunately, sire evaluations on a within-herd basis are not as accurate as those on a multiherd basis. Consequently, predicted averages are not provided as they are for sires in AI. Herdmate comparisons are made, however, and these comparisons are very useful in evaluating natural-service bulls and in estimating the future performance of their progeny in the herd.

Improvement Through Culling of Females

Genetic progress by selection of cows is difficult because of limited opportunity to select on the basis of production. Selection can be made more effective by good herd management, which reduces losses of cows because of injury, mastitis, disease, and failure to conceive.

DHIA production records should be studied carefully to evaluate the producing ability of each cow. Consideration should be given to both fortunate and unfortunate circumstances that may affect the production records of an individual cow. It is important to remember that length of lactation and age may influence production. When incomplete records are used, it is helpful to use extension factors to adjust the record to a 305-day basis. It may also be helpful to use mature-equivalent (ME) factors to reduce the effect of age differences between cows. These factors may be obtained from your county agent or State dairy specialists.

To make rapid progress in improving the inheritance for milk production through selection or culling of cows, it is important to be able to rank cows in the herd with reasonable accuracy.

The following methods may be used in ranking cows according to production:

1. Rank according to the 305-day, ME records that were initiated during the previous 12 months or year-season.
2. Rank 2-year-olds according to either actual or 305-day, ME records.

3. With all available 305-day, ME records representing living cows, determine average production per cow and adjust for differences in the number of records, using the factors shown below.

4. With all available 305-day, ME records representing living cows, determine the difference between each record and those involving contemporary herdmates; average these differences (which may be plus or minus) for each cow; and adjust for record number, using the factors shown below.

Although methods 3 and 4 are more difficult than the first two, they will provide more accurate evaluations.

Number of records:	*Factor to use*
1	0.500
2	.667
3	.750
4	.800
5 or more	.833

Appendix

Memorandum of Understanding
between
The Cooperative Extension Service
of the

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and
The Federal Extension Service
and
The Animal Husbandry Research Division
Agricultural Research Service
United States Department of Agriculture

Relating to the National Cooperative Dairy Herd Improvement and Sire Evaluation Programs

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The Cooperative Extension Service of the _____ _____, hereinafter referred to as the Agency, the Federal Extension Service, hereinafter referred to as the Service, and the Animal Husbandry Research Division, hereinafter referred to as the Division, recognizing that cooperation is a matter of working together toward a common end and is not merely one of cooperative financing, desire to enter into this memorandum of understanding for conducting work on the National Cooperative Dairy Herd Improvement and Sire Evaluation Programs.

Participation in this cooperation on the part of the Division is under authority included in the Act establishing the Department of Agriculture, the Department of Agriculture Organic Act of 1944, and the annual appropriation Acts providing funds for the activities of the Division. Participation by the Agency shall be in accordance with applicable laws.

The National Cooperative Dairy Herd Improvement and Sire Evaluation Programs, sponsored by the parties to this agreement, are cooperative undertakings between dairymen, county, State and the Service, and the Division. The National Cooperative Dairy Herd Improvement Program consists of four production recordkeeping plans: Standard Dairy Herd Improvement Association, Dairy Herd Improvement Registry Plan (in cooperation with the various breed registry organizations), Owner-Sampler Plan, and Weigh-a-Day-a-Month Plan. These plans are conducted on a national basis under the general supervision of the Animal Husbandry Research Division, Agricultural Research Service, USDA. The responsible supervising agency in each State is the Cooperative Extension Service. Participating dairymen are organized into State and county cooperatives or associations that have certain responsibilities delegated to them by the supervising agency.

The National Cooperative Dairy Herd Improvement and Sire Evaluation Programs, as they have been developed in the United States, have been effective educational methods to promote higher production per cow and more effective management of dairy cattle. The results of this improvement are demonstrated by the fact that all Standard Dairy Herd Improvement Association cows averaged 10,796 pounds of milk and 418 pounds of butterfat in 1961, compared to the national average for non-DHIA cows of 6,780 pounds of milk and 254 pounds of butterfat. The program has grown to the point where almost 69,000 cooperating dairymen are keeping dairy production records at their own expense on more than 2½ million cows in 50 States and Puerto Rico.

I. *Purposes:*

A. To improve the producing ability of dairy cattle by providing guides for breeding, feeding, and management practices.

B. To provide information by which it is possible to measure the transmitting abilities of dairy sires to the end that the meritoriously evaluated sires can be selected for breeding purposes.

C. To improve the efficiency and financial position of all dairymen.

D. To provide data for dairy extension workers in developing and conducting effective educational demonstrations and programs.

E. To provide data for research.

II. *Objectives:*

A. To maintain a uniform system of recordkeeping to guide the cooperating dairymen in their herd improvement program and to supply reliable records and

herd improvement information to the Division, the agricultural colleges, and the county, State, and the Service for scientific studies, result demonstrations, and other educational programs.

B. To establish sources of superior dairy inheritance as a means of improving the producing ability of all dairy cattle.

C. To maintain a high standard of integrity in the above recordkeeping system that will give reliability to scientific studies and educational demonstrations; provide authentic information to dairymen who use these records as a basis of breeding, sire selection, feeding, and management; and provide accurate factual information on production, feed costs, reproduction, and other herd data.

D. To summarize, analyze, and publish Standard Dairy Herd Improvement Association results and make them available to all research, educational, and extension workers; cooperating dairymen; and others. No copyright shall subsist in the material published pursuant hereto.

E. To demonstrate the fundamentals of dairy herd improvement to the cooperating dairymen and through the use of the results of this demonstration to teach all interested dairymen of the Nation the value of these practices.

III. *The Agency will—*

A. Assume responsibility for the development and guidance of the National Cooperative Dairy Herd Improvement Program and adaptation of the details of the program to fit the State needs.

B. Conduct a program to keep as many cows as possible on production testing with adequate supervision.

C. Through the State dairy extension specialist, be responsible for—

1. General supervision of the National Cooperative Dairy Herd Improvement Program in the State.

2. Distribution of all record forms, including the report forms provided by the Division which may be needed by the State.

3. Assembling and forwarding, to the Division, production records of all herds enrolled in Owner-Sampler and Weigh-a-Day-a-Month record plans and lactation and herd records of all Standard Dairy Herd Improvement Association cows for use in evaluating sires and other analyses.

4. Summarization and analysis of Dairy Herd Improvement results not supplied by the Division.

5. Making the published results available to county agricultural agents, other extension workers, and other interested parties.

6. Assisting county agricultural agents in the organization, development, and supervision of the National Cooperative Dairy Herd Improvement Program.

7. Training of Dairy Herd Improvement Association supervisors, county agricultural agents, and other personnel working on the program.

D. Through the county agent or other authorized person, be responsible for—

1. General supervision of the National Cooperative Dairy Herd Improvement Program in the county.

2. Distribution of recordkeeping forms and information to cooperating dairymen in the county.

3. Collection of necessary reports and forwarding them to the dairy specialist in charge at the State office.

4. Establishing and maintaining a responsible membership organization for the conduct of the National Cooperative Dairy Herd Improvement Program.

5. Returning to the membership the summaries and results of the testing work.

IV. *The Division will—*

A. Furnish the Agency the necessary uniform lactation and herd report forms (except EDPM monthly report and State adapted forms) needed to provide essential information for the dairymen and data for research analysis, extension teaching, and sire evaluation.

B. Conduct a sire evaluation program based on data received from the Agency and publish the results thereof. Make available sire data for further study and extension use in dairy cattle improvement.

C. Compile summary information on a regional and national basis on all types of dairy production recordkeeping and analyze Standard Dairy Herd Improvement Association production, feed, and cost data from data received from the Agency to show the value of various dairy practices and make these results available to the Agency for extension teaching.

D. Assist in coordinating the State Dairy Herd Improvement Programs with the national program.

E. Conduct research on the various aspects of the program to assure an efficient and economical operation.

F. Furnish an annual report of record forms and other pertinent statistical data to the director of the Agency.

V. *It is mutually agreed that—*

A. The Agency which will be represented by the Dairy Records Committee of the American Dairy Science Association and the Division, working through the American Dairy Science Association, shall establish uniform rules and policies for conducting the Dairy Herd Improvement and Sire Evaluation Programs.

B. The Agency and the Division will consult in the interest of effective cooperation and coordination with respect to all phases of the Dairy Herd Improvement and Sire Evaluation Programs.

C. A representative of the Service will serve as a liaison between the Agency, the Division, and the Extension Committee on Organization and Policy.

D. The Agency and the Division will cooperate in establishing and maintaining Dairy Records Processing Laboratories and collaborate on other regional or national activities to improve the effectiveness of Dairy Herd Improvement and Sire Evaluation Programs.

E. The Agency and the Division will pay the salaries and expenses of their respective employees assigned to this work.

VI. This memorandum of understanding is to define in general terms the basis on which the parties concerned will cooperate and does not constitute a financial obligation to serve as a basis for expenditures. Each party will handle and expend its own funds. Any and all expenditures by the Division made in conformity with the plans outlined in this memorandum of understanding must be in accord with Department rules and regulations, and in each instance based upon appropriate finance papers, such as lease, contract, requisition, letter of authorization, etc. Expenditures made by the Agency will be in accord with its governing rules and regulations.

VII. The responsibilities assumed by each of the cooperating parties are contingent upon funds being

available from which expenditures legally may be made.

Funds of the Agency shall not be expended by any employee of the Division.

VIII. No member of, or delegate to, Congress or resident commissioner, and no officer, agent, or employee of the Government shall be admitted to any share or part of this agreement or to any benefit to arise therefrom.

IX. This memorandum of understanding shall become effective when fully executed. It shall continue in effect indefinitely but may be modified or terminated at the request of either party. Requests for termination or any major modification shall be submitted to the other party for consideration not less than six (6) months in advance of the effective date of such termination or change.

X. Nothing herein shall be construed as interfering in any way with the basic responsibilities and activities of either party.

(Date) _____

*Director, Cooperative Extension Service of the*_____

(Date) _____

Administrator
Agricultural Research Service
United States Department of Agriculture

(Date) _____

Administrator
Federal Extension Service
United States Department of Agriculture

DHIA Rules

(Revised and Approved by the American Dairy Science Association in June 1962)

Rule 1. Standard Equipment and Methods

All equipment and methods shall conform to the standards and methods set by the American Dairy Science Association and/or the State Regulatory Agency. The accuracy of all equipment shall be checked as frequently as necessary to insure that equipment is operating within the standards established by ADSA.

The ADSA Dairy Records Committee will offer an opinion of accuracy of equipment or method when they have been tested and results published by three or more colleges, experiment stations, or independent research laboratories. The responsible supervising agency and/or the regulatory agency in each State shall have authority to approve equipment or methods found to produce results within tolerances established by the ADSA Dairy Records Committee.

Tolerances are as follows:

A. Butterfat test on individual cows should be within plus or minus 0.2 of the fat test obtained by conventional sampling methods.

B. Daily milk weights as compared to an accurate scale should be within 3 percent or one-half pound, whichever is the greater, and the error should be random so it will cancel with repeated sampling.

90 percent of the tests and weights should fall within these limits.

Rule 2. Cooperation of Owner

Owners must make available all registration certificates and other information for permanent identification of animals on test and all their offspring. They must provide the supervisor with freshening and dry dates, purchase and sale dates, abortion dates, and death dates. When requested they must cooperate and assist the supervisor in obtaining feed weights, roughage quality, value of product, breeding dates, and any information needed for calculation of complete DHIA records.

Rule 3. Identification of Animals

Every animal in DHIA herds must be positively identified and recorded in the owner's herd book within 60 days after entering the herd by birth or purchase. A herd registry page is provided for this purpose. Cows on test must be permanently identified with (1) registration numbers if registered, or (2) uniform series eartags as used in DHIA, disease eradication, and artificial breeding (State code, 1-, 2-, or 3-letter prefix, 4 digits).

The supervisor shall verify the identity of each cow when entered on test, by registration certificates if registered or by eartag numbers if not registered, and record the information on appropriate forms. Thereafter, at each milking the supervisor must assure himself of the correct identity of each cow as she is milked.

Tattoo numbers, branded numbers, or private eartags are acceptable identification, provided that they are cross-indexed to one of the above identification systems.

Supplemental Identification.—Neck chains, strap numbers, or other numbering systems may be used on young stock until they enter the milking herd. They also may be used as secondary identification for milking cows, provided that they are cross-indexed with permanent identification.

Rule 4. Production Reports

DHIA lactation records shall be computed and reported for every cow on test for each calving. Monthly and yearly herd reports shall also be computed and reported as required by the county and State extension service.

Rule 5. Cows To Be Tested

DHIA records must be kept on all dairy cows in the herd or on the farm that have ever calved, regardless of ownership, except as specified in the rule on permanent nurse cows. DHIA herds shall consist of all cows that have freshened at least once located on one or more farms under one management.

Members owning or operating more than one farm may divide their herds into farm units, and each may be tested as a separate unit when the units are maintained as separate herds and there is no shifting of cows between herds. In single herds involving two or more distinctly individual breeds, separate herd averages or a composite herd average may be calculated and reported as such.

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The owner or his management is required to report to the supervisor all cows added to or removed from the herd since the previous test, as well as first-calf heifers that have calved.

In any case involving the questionable assignment of cows to a herd to influence a herd average, the decision of the local or State board of directors in council with the State extension dairyman in charge of production testing shall be considered final. In special cases involving joint operation of herds or groups of cows, the local board of directors in council with the State extension dairyman shall decide the policy.

Rule 6. Monthly and Bimonthly Testing

Associations may operate on the monthly or bimonthly basis or on both, as approved by the State extension dairyman.

Rule 7. Number of Cows Tested Daily

The number of cows and herds tested daily shall be left to the judgment and discretion of the DHIA board of directors and State extension dairyman concerned. They will consider the ability of the supervisor, milking facilities, and type of records being kept.

The number of cows tested shall be limited as much as necessary to allow sufficient time for the supervisor on each visit to the farm to properly comply with all the Standard DHIA Rules, such as the identification of all animals in the herd, including eartagging when necessary; proper supervision of milking, including the identification of the cows being milked; using the proper procedures and methods of sampling, including the handling of samples and the use of a locked sample case; obtaining and using his own data; properly recording data on the barn sheet; keeping the owner's herd book up to date; and making all required monthly, yearly, and lactation reports. Sufficient time also shall be allowed for the supervisor to check all his work and reports for accuracy before leaving the farm.

Rule 8. Supervision of Milkers and Cows

The herd owner shall milk his cows in such order that on the testing day cows being milked at the same time will be in close proximity and full view of the supervisor for observation.

The supervisor must be in position to observe the milkers, machines, and cows during the entire milking process.

Rule 9. Supervisor Uses Own Data

The supervisor, or a person or central processing service authorized and approved by the State extension dairyman and the responsible organization, shall compute the production records for a testing period from the data obtained on the testing date.

Rule 10. Centering the Testing Day

Production records shall be calculated by centering the testing day according to the method outlined in the DHIA Supervisor's Manual. All tests shall be applied to the testing period in which made.

Rule 11. Supervisor's Route

In order that the herd owner may not know the exact day the supervisor will visit a farm, the supervisor shall from time to time vary his visits to each farm as much as 3 days ahead of, or 3 days after, the centering day.

Rule 12. Lock Sample Cases

All milk samples, glassware, and the current monthly barn sheet with recorded test day data shall be securely locked by the supervisor when they are not under his immediate observation.

Rule 13. Methods of Sampling

All weighing, sampling, and recording of each milking of each cow for the 24-hour period must be done by the supervisor or person authorized by the local DHIA board of directors. Each cow's milk must be thoroughly mixed immediately before sampling.

Rule 14. Lost Samples

When a sample is lost, the previous month's butterfat test shall be used. When milk weights are not obtained, the pounds of milk for the current testing day shall be estimated from the previous month's record by use of the nurse-cow table in the DHIA Supervisor's Manual. In either case, the record shall be marked "estimated."

Rule 15. Abnormal Tests

In cases of severe sickness or injury, except for the first month of lactation, a 40-percent change in total daily pounds of fat from the preceding test *shall* be considered abnormal. Abnormal high or low records due to causes such as sickness, severe injury, and off feed shall be handled similarly to lost samples.

Rule 16. Retests, Owner's Request

If for any reason a herd owner is not satisfied with the test on his herd, he may call for a retest. The herd owner shall pay the cost of the retest unless otherwise determined by the local board of directors. The use of the requested retest and the regular test shall be at the discretion of the State extension dairyman.

Rule 17. Surprise Tests—DHIA

Surprise tests may be conducted for verification of records of high producing cows and herds and for investigation of rule infractions. They may be ordered by the State or local organization and/or the State extension dairyman.

The use of the surprise test and the payment thereof shall be determined by the organization requiring such tests. Surprise tests shall be preceded by a preliminary dry milking.

Rule 18. Surprise Tests—DHIR

The DHIR surprise test rules are as follows:

A. Production requirements

The State official in charge of DHIA testing shall arrange for surprise testing of cows that meet the

following production requirements, or when requested to do so by the breed registry organization:

1. If, after 90 days of a lactation, a cow equals or exceeds the average daily butterfat production shown in column A of the accompanying table, one surprise test with a preliminary dry milking shall be made within the next 2 months, if possible.

2. If after 90 days of a lactation, a cow equals or exceeds the average daily butterfat production shown in column B of the table, a second test with a preliminary dry milking shall be made before the 305th day of her lactation.

B. Use of Surprise Test

The surprise test shall be used in lieu of the regular test and, if possible, shall be made by a different supervisor. Whether or not a regular test shall also be conducted during the testing period is left to the discretion of the local DHIA board of directors.

C. The Preliminary Milking

The preliminary milking need not be sampled or tested.

D. Cows To Be Included

1. When a surprise test is made in lieu of a regular test, the entire herd shall be included.

2. When a surprise test is made as an additional test during a testing period, it shall include the entire herd, except that in herds requiring more than 1 day's supervision, only those cows meeting the surprise test requirements need be included.

Surprise Test Production Requirements

Age	Col. A	Col. B
2 years	2.8 lbs. fat daily	2.9 lbs. fat daily.
3 years	3.1 lbs. fat daily	3.3 lbs. fat daily.
4 years and over	3.4 lbs. fat daily	3.7 lbs. fat daily.

Rule 19. Fresh Cows—Dry Cows—Cows Sold

A cow shall not be tested until the seventh day after she calves, counting the day of calving as the first day. The record, however, is started on the fourth day after calving, counting the calving day as the first day. Cows freshening after the supervisor's regular visit and before the end of the testing period shall be given credit for their production during that period, as calculated on the basis of the results of the next test. Dry cows—the dry date is the first day the cow is not milked. The day a cow is sold and leaves the herd counts as the last day in the herd, and she gets production for that full day.

Rule 20. Aborting Cows or Cows Freshening Without Going Dry

In case a cow aborts while dry, her record shall be figured the same as for a fresh cow. If she aborts while in milk and has carried a calf less than 152 days, her current record shall continue without interruption. If a breeding date is not available and the cow aborts while in milk for less than 200 days, her current record shall continue without interruption. Otherwise the current record shall end, and a new lactation shall begin.

Rule 21. Cows Nursing Calves

Temporary nurse cow

Cows nursing calves on the testing day are considered on test. Records other than production are taken as usual and recorded in the herd-record book. No milk samples are taken. Milk weights and tests obtained on the last testing day before calves are put on cows or on the first testing day after calves have been removed are used in computing production for the testing period in which calves are nursed, along with the nurse-cow table in DHIA Supervisor's Manual.[1] The recorded number of days in milk for the lactation shall include the number of days the cows nursed calves during the lactation period.

If records are calculated by a computing center, they will be coded as required.

Permanent nurse cow

At the request of the herd owner, a cow that is to be used as a nurse cow throughout the entire lactation period may be removed from test from the date of freshening until the following date of freshening, provided she has at least one complete lactation record.

Permanent nurse cows are to be reentered on test at the following calving unless they are requalified. Cows are disqualified as permanent nurse cows if at any time they are milked by machine or by hand.

Rule 22. Yearly Herd Average

The yearly herd average is calculated on a cow-year basis. As outlined in the footnotes on the monthly herd summary, DHIA–12, the total number of cow-days on test for the year is divided by 365 (366 in a leap year) to obtain the number of cow-years. The totals for the year are divided by the number of cow-years to obtain the herd averages for the year.

Rule 23. Yearly Association Average

The association average is found by dividing the total pounds of milk and total pounds of butterfat by the total cow-years.

Rule 24. Computing Fractions

The weights of milk at each milking and the day's total of milk are to be recorded to the nearest one-tenth of a pound, the month's milk to the nearest 10 pounds. Butterfat tests shall be recorded to the nearest one-tenth of a percent and monthly butterfat to the nearest pound. The price per hundredweight of milk and feed may be taken to the nearest 10 cents. The value of product and cost of feed may be to the nearest whole dollar. If the fraction is less than half, drop it. If half or more, change to the next highest number.

Rule 25. Fraudulent Practices

Any practice that is intended to create or does create any abnormal percentage of butterfat or an abnormal yield of milk is a violation of DHIA rules. Fraudulent practices shall be referred to the local DHIA board of

[1] The nurse-cow table is included in this handbook as table 3 in the appendix.

directors for their consideration. The local board of directors shall decide what action is necessary to prevent or correct such practices.

Rule 26. Relation of Supervisors and Owners

As an employee of the local dairy herd improvement association, the supervisor's duty is to see that the tests are honestly made, accurately recorded, and completely reported. No payment, gift, or gratuity to supervisor is permitted from the owner of a cow or anyone interested in her. The supervisor may act as a collecting agent for the association. He may collect payment for dues and fees for the association, provided a receipt is given the member and a carbon copy of the same receipt is given to the association treasurer. The supervisor shall not test his own herd nor the herd of the immediate members of his family. The supervisor is not at liberty to decide which rules are essential and which are not, but is required to observe all of them in detail. Owners or persons in their employ are equally held responsible with the supervisor for enforcement of these rules.

Rules Applying to DHIR Testing

1. Organization and Supervisional Authority

The DHIR production testing program shall be conducted under the joint administration of the State extension dairyman or other State official in charge of DHIA testing within a particular State and the superintendent of official testing of the appropriate breed registry organization. The State official in charge of DHIA testing shall be responsible for supervising all records in strict accordance with the rules and regulations for standard DHIA testing, the additional requirements set forth herein, and any additional requirements of the appropriate breed registry organization. He shall assume responsibility for the enforcement of all such rules and regulations and shall withhold approval of production records from a herd owner or from a DHIA supervisor which are not made in strict accordance with the rules and regulations. He shall have the further responsibility of calling to the attention of the superintendent of official testing of the appropriate breed registry organization all failures by herd owners to comply with the rules of the DHIR testing program.

It is understood that DHIA records from any herd or any DHIA where the compensation of the DHIA supervisor is made directly by the herd owner will not be accepted or approved under this plan. The superintendent of official testing of the breed registry organization shall be responsible for advising the State official in charge of DHIA testing on all matters concerned with the acceptance of DHIR records by the appropriate breed registry organization. The superintendent of official testing of the appropriate breed registry organization reserves the right to accept or reject any records reported by the State official in charge of DHIR testing within the State and assumes full responsibility for initiating any and all disciplinary action concerned with records in progress or already accepted and approved by the breed registry organization.

2. Basic Data

A. *Identification of Animals.*—At the time of the first test of a herd for which an application has been filed for the acceptance of DHIR records, the DHIA supervisor must positively identify each cow in the herd by comparison of the color markings or tattoo mark in the ear with the registry certificate and must make sure that all registered cows owned by the applicant are tested. New cows entering the herd by purchase or freshening must be similarly identified at the time of their first test supervision.

B. *Supplemental Identification.*—Supplemental identification such as numbers or sealed collars or sealed neck chains, numbers branded on the cows, or other permanent nontransferable identification marks which have been properly cross-checked with the registration certificates, may be used for positive identification at succeeding monthly test supervisions. Unless such suitable supplemental identification is provided and maintained by the owner, the registration certificates must be used at each monthly test for identification of all animals tested. The DHIA supervisor will be held responsible for the absolute accuracy of identification of all cows tested at each test period.

C. *The DHIA Supervisor.*—The DHIA supervisor will be responsible for reporting each month any change in status of each cow in the herd, such as calving date, purchase date, date of sale and for what purpose, or other dates affecting the production record of each animal, as well as the milk production and butterfat test of each cow during the test period. He shall also report any unusual or abnormal conditions that may affect the reliability of the test, and any violations of the rules by the owner or attendants shall be reported immediately by the DHIA supervisor to the State official in charge of DHIR testing within the State.

D. *The Herd Owner.*—The herd owner shall be responsible for providing, at the time of each monthly test, all basic data needed by the supervisor for a complete and accurate report on each cow in the herd. He shall be also responsible for supplying the supervisor with complete information on cows removed from the herd.

3. Surprise Tests

The State official in charge of DHIR testing shall arrange for surprise tests when the conditions of Rule 18, DHIA rules (appendix) are met, or when requested to do so by the breed registry organization.

4. Availability of Data

Uniform production data and other data pertinent to the production record shall be provided to the appropriate breed registry organization from the State or regional DHIA processing laboratory on all registered cows in herds enrolled in the DHIR testing program. The processing laboratory shall make two reports for each cow. The first of these reports shall include any and all production for a lactation up to

305 days in length; reports of such lactation records shall include all production from date of freshening or date of entering the herd to dry date or to date of disposal; reports of such records shall be forwarded at intervals of not more than 90 days. These reports shall be transmitted by the State or regional DHIA processing laboratory to the breed registry organizations on PDCA *form* 1.

In electronic processing and calculation of production records, the milk weights of each milking shall be added electronically to obtain daily milk weights; the days in the testing period shall be electronically computed from the dates reported; and 305-day and total lactation records shall be electronically computed and reported only after the cow has actually milked 305 days or has completed her lactation.

5. Costs for DHIR Testing

Each breed organization shall set its own fees for entering a herd on DHIR test. It shall be an annual fee, payable at the time of application, and at yearly intervals thereafter. Notice shall be given by the breed registry organization to the State official in charge of DHIA testing when a breeder has made application for DHIR testing.

The annual testing fee assessed by the breed registry organization shall include a fee to be paid to the State or regional DHIA processing laboratory to defray its costs for reporting DHIR records to the breed registry organization. Payment shall be made to the processing laboratory on a regular basis as reports of DHIR records are received by the breed registry organization.

TABLE 1.—*Centering date table—Monthly*

Centering date	January, August (31 days)	February (28 days)	February (29 days)	March (31 days) following February (28 days)	March (31 days) following February (29 days)	April, June, September, November (30 days)	May, July, October, December (31 days)	Centering date
1st	*17 to 16	*17 to 13	*17 to 14	*14 to 16	*15 to 16	*17 to 15	*16 to 16	1st
2d	*18 to 17	*18 to 14	*18 to 15	*15 to 17	*16 to 17	*18 to 16	*17 to 17	2d
3d	*19 to 18	*19 to 15	*19 to 16	*16 to 18	*17 to 18	*19 to 17	*18 to 18	3d
4th	*20 to 19	*20 to 16	*20 to 17	*17 to 19	*18 to 19	*20 to 18	*19 to 19	4th
5th	*21 to 20	*21 to 17	*21 to 18	*18 to 20	*19 to 20	*21 to 19	*20 to 20	5th
6th	*22 to 21	*22 to 18	*22 to 19	*19 to 21	*20 to 21	*22 to 20	*21 to 21	6th
7th	*23 to 22	*23 to 19	*23 to 20	*20 to 22	*21 to 22	*23 to 21	*22 to 22	7th
8th	*24 to 23	*24 to 20	*24 to 21	*21 to 23	*22 to 23	*24 to 22	*23 to 23	8th
9th	*25 to 24	*25 to 21	*25 to 22	*22 to 24	*23 to 24	*25 to 23	*24 to 24	9th
10th	*26 to 25	*26 to 22	*26 to 23	*23 to 25	*24 to 25	*26 to 24	*25 to 25	10th
11th	*27 to 26	*27 to 23	*27 to 24	*24 to 26	*25 to 26	*27 to 25	*26 to 26	11th
12th	*28 to 27	*28 to 24	*28 to 25	*25 to 27	*26 to 27	*28 to 26	*27 to 27	12th
13th	*29 to 28	*29 to 25	*29 to 26	*26 to 28	*27 to 28	*29 to 27	*28 to 28	13th
14th	*30 to 29	*30 to 26	*30 to 27	*27 to 29	*28 to 29	*30 to 28	*29 to 29	14th
15th	*31 to 30	*31 to 27	*31 to 28	*28 to 30	*29 to 30	*31 to 29	*30 to 30	15th
16th	1 to 31	1 to 28	1 to 29	1 to 31	1 to 31	1 to 30	1 to 31	16th
17th	2 to 1**	2 to 1**	2 to 1**	2 to 1**	2 to 1**	2 to 1**	2 to 1**	17th
18th	3 to 2**	3 to 2**	3 to 2**	3 to 2**	3 to 2**	3 to 2**	3 to 2**	18th
19th	4 to 3**	4 to 3**	4 to 3**	4 to 3**	4 to 3**	4 to 3**	4 to 3**	19th
20th	5 to 4**	5 to 4**	5 to 4**	5 to 4**	5 to 4**	5 to 4**	5 to 4**	20th
21st	6 to 5**	6 to 5**	6 to 5**	6 to 5**	6 to 5**	6 to 5**	6 to 5**	21st
22d	7 to 6**	7 to 6**	7 to 6**	7 to 6**	7 to 6**	7 to 6**	7 to 6**	22d
23d	8 to 7**	8 to 7**	8 to 7**	8 to 7**	8 to 7**	8 to 7**	8 to 7**	23d
24th	9 to 8**	9 to 8**	9 to 8**	9 to 8**	9 to 8**	9 to 8**	9 to 8**	24th
25th	10 to 9**	10 to 9**	10 to 9**	10 to 9**	10 to 9**	10 to 9**	10 to 9**	25th
26th	11 to 10**	11 to 10**	11 to 10**	11 to 10**	11 to 10**	11 to 10**	11 to 10**	26th
27th	12 to 11**	12 to 11**	12 to 11**	12 to 11**	12 to 11**	12 to 11**	12 to 11**	27th
28th	13 to 12**	13 to 12**	13 to 12**	13 to 12**	13 to 12**	13 to 12**	13 to 12**	28th
29th	14 to 13**	----------	14 to 13**	14 to 13**	14 to 13**	14 to 13**	14 to 13**	29th
30th	15 to 14**	----------	----------	15 to 14**	15 to 14**	15 to 14**	15 to 14**	30th
31st	16 to 15**	----------	----------	16 to 15**	16 to 15**	----------	16 to 15**	31st

*Date of previous month.
**Date of following month.

TABLE 2.—*Centering date table—Bimonthly*

Centering date	January (62 days)	February (59 days)	March (59 days)	April, June, Sept., Nov. (61 days)	May, July, Oct., Dec. (61 days)	August (62 days)	Centering date
1st	*1 to 31	*1 to 28	*1 to 31	*1 to 30	*1 to 31	*1 to 31	1st
2d	*2 to 1**	*2 to 1**	*2 to 1**	*2 to 1**	*2 to 1**	*2 to 1**	2d
3d	*3 to 2**	*3 to 2**	*3 to 2**	*3 to 2**	*3 to 2**	*3 to 2**	3d
4th	*4 to 3**	*4 to 3**	*4 to 3**	*4 to 3**	*4 to 3**	*4 to 3**	4th
5th	*5 to 4**	*5 to 4**	*5 to 4**	*5 to 4**	*5 to 4**	*5 to 4**	5th
6th	*6 to 5**	*6 to 5**	*6 to 5**	*6 to 5**	*6 to 5**	*6 to 5**	6th
7th	*7 to 6**	*7 to 6**	*7 to 6**	*7 to 6**	*7 to 6**	*7 to 6**	7th
8th	*8 to 7**	*8 to 7**	*8 to 7**	*8 to 7**	*8 to 7**	*8 to 7**	8th
9th	*9 to 8**	*9 to 8**	*9 to 8**	*9 to 8**	*9 to 8**	*9 to 8**	9th
10th	*10 to 9**	*10 to 9**	*10 to 9**	*10 to 9**	*10 to 9**	*10 to 9**	10th
11th	*11 to 10**	*11 to 10**	*11 to 10**	*11 to 10**	*11 to 10**	*11 to 10**	11th
12th	*12 to 11**	*12 to 11**	*12 to 11**	*12 to 11**	*12 to 11**	*12 to 11**	12th
13th	*13 to 12**	*13 to 12**	*13 to 12**	*13 to 12**	*13 to 12**	*13 to 12**	13th
14th	*14 to 13**	*14 to 13**	*14 to 13**	*14 to 13**	*14 to 13**	*14 to 13**	14th
15th	*15 to 14**	*15 to 14**	*15 to 14**	*15 to 14**	*15 to 14**	*15 to 14**	15th
16th	*16 to 15**	*16 to 15**	*16 to 15**	*16 to 15**	*16 to 15**	*16 to 15**	16th
17th	*17 to 16**	*17 to 16**	*17 to 16**	*17 to 16**	*17 to 16**	*17 to 16**	17th
18th	*18 to 17**	*18 to 17**	*18 to 17**	*18 to 17**	*18 to 17**	*18 to 17**	18th
19th	*19 to 18**	*19 to 18**	*19 to 18**	*19 to 18**	*19 to 18**	*19 to 18**	19th
20th	*20 to 19**	*20 to 19**	*20 to 19**	*20 to 19**	*20 to 19**	*20 to 19**	20th
21st	*21 to 20**	*21 to 20**	*21 to 20**	*21 to 20**	*21 to 20**	*21 to 20**	21st
22d	*22 to 21**	*22 to 21**	*22 to 21**	*22 to 21**	*22 to 21**	*22 to 21**	22d
23d	*23 to 22**	*23 to 22**	*23 to 22**	*23 to 22**	*23 to 22**	*23 to 22**	23d
24th	*24 to 23**	*24 to 23**	*24 to 23**	*24 to 23**	*24 to 23**	*24 to 23**	24th
25th	*25 to 24**	*25 to 24**	*25 to 24**	*25 to 24**	*25 to 24**	*25 to 24**	25th
26th	*26 to 25**	*26 to 25**	*26 to 25**	*26 to 25**	*26 to 25**	*26 to 25**	26th
27th	*27 to 26**	*27 to 26**	*27 to 26**	*27 to 26**	*27 to 26**	*27 to 26**	27th
28th	*28 to 27**	*28 to 27**	*28 to 27**	*28 to 27**	*28 to 27**	*28 to 27**	28th
29th	*29 to 28**	----------	1 to 28**	*29 to 28**	*29 to 28**	*29 to 28**	29th
30th	*30 to 1 [1]	----------	2 to 29**	*30 to 29**	*30 to 29**	*30 to 29**	30th
31st	*31 to 2 [1]	----------	3 to 30**	----------	1 to 30**	*31 to 30**	31st

*Date of previous month. **Date of following month. [1] Date of 2d following month.

Estimating Missing Monthly Test-Day Records

Table 3 provides a means for estimating test-day production for months of test missed because the animal was used as a nurse cow or the milk sample was lost, or for some other reason. To use this table, locate the test-day weight for the last available testing period or for the first period after testing is resumed, and use the test-day weight listed in the succeeding or preceding column for that line. A testing period should be counted separately only if a cow has milked at least 15 days in the period. If the first month is missed, find the test-day weight for the second month of test in column 2 and use the corresponding weight in the first column. For example: If the production for month 2 is 29 pounds, the production for month 1 is estimated as 28 pounds. To determine butterfat credit, use the butterfat test for the last (or first) available testing period.

TABLE 3.—*Estimating missing monthly test-day records* [1]

Estimated 305-day production	Estimated daily production for each testing period [2]									
	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
4, 360	20	21	20	18	16	15*	12	10*	6. 6	4. 1
4, 550	21	22	21	19	17	15	13	10	7. 0	4. 3
4, 790	22	23	22*	20*	18*	16*	14*	11*	7. 2	4. 5
5, 030	23	24	23	21*	19*	17*	14	11	7. 6	4. 7
5, 250	24	25	24*	22*	20*	17	15*	12*	7. 9	4. 9
5, 430	25	26	25	23*	21*	18	16*	12	8. 3	5. 1
5, 680	26	27	26*	24*	21	19*	16	13*	8. 6	5. 3
5, 920	27	28	27	25*	22	20*	17*	13	9. 0	5. 6
6, 070	28	29	28*	25	23*	20	17	14*	9. 2	5. 7
6, 290	29	31*	29	26	24*	21	18	14	9. 6	6. 0

See footnotes at end of table.

TABLE 3.—*Estimating missing monthly test-day records* [1]—Continued

Estimated 305-day production	Estimated daily production for each testing period [2]									
	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th
6, 560	30	32*	30*	27	25*	22*	19*	15*	9. 9	6. 1
6, 740	31	33*	31	28*	25	22	19	15	10. 2	6. 3
7, 010	32	34*	32*	29	26	23	20*	16*	10. 6	6. 6
7, 200	33	35*	33	30	27	24	20	16	10. 9	6. 8
7, 440	34	36*	34*	31*	28*	25*	21	17*	11. 3	7. 0
7, 630	35	37*	35	32*	29*	26*	22*	17	11. 7	7. 3
7, 840	36	38*	36*	33*	29	26	22	18*	11. 9	7. 4
8, 080	37	39*	37	34*	30	27	23	18	12. 3	7. 6
8, 330	38	40*	38*	35*	31	28*	24*	19*	12. 6	7. 8
8, 480	39	41	39	36*	32	29*	24	19	13. 0	8. 1
8, 720	40	42	40*	36	33*	29	25*	20*	13. 3	8. 2
8, 900	41	43	41*	37	34*	30*	25	20	13. 5	8. 4
9, 180	42	44	42*	38	34	31*	26*	21*	13. 9	8. 6
9, 400	43	45	43*	39	35	31	27*	21	14. 2	8. 8
9, 610	44	46	44*	40*	36*	32*	27	22*	14. 4	8. 9
9, 820	45	47	45*	41*	37*	33*	28*	22	14. 8	9. 2
10, 030	46	48	46*	42*	38*	34*	29*	23*	15. 3	9. 5
10, 250	47	49	47*	43*	38	34	29	23	15. 6	9. 7
10, 490	48	50	48*	44*	39	35*	30*	24*	15. 9	9. 9
10, 650	49	52*	49*	45*	40	36*	30	24	16. 2	10. 0
10, 920	50	53*	50*	45	41*	36	31*	25*	16. 5	10. 2
11, 170	51	54*	51*	46	42*	37	32*	25	16. 9	10. 5
11, 350	52	55*	52*	47	43*	38*	32	26*	17. 2	10. 7
11, 590	53	56*	53*	48	43	39*	33*	26	17. 6	10. 9
11, 780	54	57*	54*	49	44	39	33	27*	17. 8	11. 0
11, 990	55	58*	55*	50	45	40	34	27	18. 3	11. 3
12, 290	56	59*	56*	51*	46*	41*	35*	28*	18. 6	11. 5
12, 440	57	60*	57*	52*	47*	42*	35	28	18. 9	11. 7
12, 660	58	61*	58*	53*	47	42	36*	29*	19. 2	11. 9
12, 870	59	62	59*	54*	48	43*	37*	29	19. 6	12. 2
13, 120	60	63	60*	55*	49	44*	37	30*	19. 9	12. 3
13, 300	61	64	61*	55	50*	44	38*	30	20. 2	12. 5
13, 540	62	65	62*	56	51*	45	38	31*	20. 5	12. 7
13, 730	63	66	63*	57	52*	46*	39*	31	20. 8	12. 9
13, 970	64	67	64*	58	52	47*	40*	32*	21. 2	13. 1
14, 150	65	68	65*	59	53	47	40	32	21. 6	13. 4
14, 430	66	69	66*	60*	54*	48	41*	33*	21. 8	13. 5
14, 610	67	70	67*	61*	55*	49*	42*	33	22. 2	13. 8
14, 850	68	71	68*	62*	56*	49	42	34*	22. 5	14. 0
15, 040	69	73*	69*	63*	56	50	43*	34	22. 9	14. 2
15, 280	70	74*	70*	64*	57	51*	43	35*	23. 2	14. 4
15, 560	71	75*	71*	65*	58	52*	44*	35	23. 5	14. 6
15, 710	72	76*	72*	65	59*	52	45*	36*	23. 9	14. 8
15, 920	73	77*	73*	66	60*	53	45	36	24. 2	15. 0
16, 170	74	78*	74*	67	61*	54*	46*	37*	24. 5	15. 2
16, 350	75	79*	75*	68	61	55*	46	37	24. 9	15. 4
16, 590	76	80*	76*	69	62	55	47	38*	25. 2	15. 6
16, 840	77	81*	77*	70	63	56	48*	38	25. 6	15. 9
17, 050	78	82*	78*	71*	64*	57*	48	39*	25. 9	16. 1
17, 230	79	83	79*	72*	65*	58*	49*	39	26. 2	16. 2
17, 420	80	84	80*	73*	65	58	49	40*	26. 5	16. 4
17, 690	81	85	81*	74*	66	59*	50	40	26. 9	16. 7
17, 900	82	86	82*	74	67	60*	51*	41*	27. 2	16. 9
18, 090	83	87	83*	75	68*	60	51	41	27. 5	17. 1
18, 330	84	88	84*	76	69*	61	52*	42*	27. 8	17. 2
18, 540	85	89	85*	77	70*	62*	53*	42	28. 2	17. 5
18, 790	86	90	86*	78	70	63*	53	43*	28. 5	17. 7
18, 970	87	91	87*	79	71	63	54*	43	28. 8	17. 9
19, 180	88	92	88*	80*	72*	64	54	44*	29. 1	18. 0
19, 430	89	94*	89*	81*	73*	65*	55	44	29. 5	18. 3
19, 670	90	95*	90*	82*	74*	65	56*	45*	29. 8	18. 5
19, 860	91	96*	91*	83*	74	66	56	45	30. 2	18. 7
20, 130	92	97*	92*	84*	75	67*	57*	46*	30. 5	18. 9
20, 280	93	98*	93*	84	76	68*	57	46	30. 8	19. 1
20, 500	94	99*	94*	85	77*	68	58	47*	31. 2	19. 3

See footnotes at end of table.

TABLE 3.—*Estimating missing monthly test-day records* [1]—Continued

Estimated 305-day production	Estimated daily production for each testing period [2]									
	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th
20, 770	95	100*	95*	86	78*	69	59*	47	31. 5	19. 5
20, 950	96	101*	96*	87	78	70*	59	48*	31. 8	19. 7
21, 170	97	102*	97*	88	79	71*	60	48	32. 2	20. 0
21, 410	98	103*	98*	89	80	71	61*	49*	32. 5	20. 2
21, 590	99	104*	99	90*	81*	72	61	49	32. 8	20. 3
21, 840	100	105	100*	91*	82*	73*	62*	50*	33. 1	20. 5
22, 910	105	110	105*	95	86	76	65	52	34. 8	21. 6
24, 000	110	116	110*	100*	90*	80*	68*	54	36. 4	22. 6
25, 100	115	121*	115*	104	94	84*	71	57*	38. 1	23. 6
26, 170	120	126	120*	109*	98	87	74	59	39. 7	24. 6
27, 270	125	131	125*	113	102	91	77	62*	41. 5	25. 7

[1] Based on factors given in table 4.

[2] Numbers marked with an asterisk (*) were raised to the nearest whole number, and these numbers should be used if a cow's daily production was similarly increased. For example, suppose in the 5th testing period a cow produced 22.5 to 22.9 pounds, the figure "23*" should be used. If her production was between 22.0 and 22.4 pounds, the figure "22" should be used. Where 1 asterisk follows another asterisk, apply the rounding rule and use the production figure that results.

For testing periods 9 and 10, daily production is carried to 1 decimal point to make it possible to determine into which line a cow's production will fall if production in one of these months is used to estimate another month's production.

Processing centers will find it convenient to use the factors presented in table 4. The factors in column 3 are more accurate than table 3, since they utilize information from the months of test immediately preceding and following the missed month.

Ratio factors for predicting a missing monthly test-day record are given below for three possibilities: (1) the preceding test-day weight is known; (2) the succeeding test-day weight is known; (3) both the preceding and succeeding test-day weights are known.

TABLE 4.—*Factors to use in estimating monthly test-day records* [1]

Month of test	Preceding test-day weight is known [2]	Succeeding test-day weight is known [3]	Both preceding and succeeding test-day weights are known [4]
1st	----------	0. 95	----------
2d	1. 05	1. 05	0. 52
3d	. 95	1. 10	. 51
4th	. 91	1. 11	. 50
5th	. 90	1. 13	. 50
6th	. 89	1. 18	. 51
7th	. 85	1. 24	. 50
8th	. 80	1. 50	. 52
9th	. 67	1. 60	. 47
10th	. 62	----------	----------

[1] Factors developed from New York DHIA Holstein data by Dr. L. D. Van Vleck and Dr. C. R. Henderson of the Department of Animal Husbandry, Cornell University, Ithaca, N.Y., and are used with their permission.

[2] To estimate the test-day milk weight for a specific testing month, multiply the factor listed under the month of test which was missed by the cow's test-day milk weight for the *previous* testing month.

[3] To estimate the test-day milk weight for a specific testing month, multiply the factor listed under the month of test which was missed by the cow's test-day milk weight for the *following* testing month.

[4] To estimate the test-day milk weight for a specific testing month, multiply the factor listed under the month of test which was missed by the sum of the test-day milk weights for the month *preceding* the missed month and the month *following* the missed month.

An example using the *preceding* test-day record follows:

Assume that a cow produced 34 pounds in month 4 of her lactation. In month 5, her milk weight was lost, or she was used as a nurse cow. To obtain her milk weight for month 5, multiply 34, the milk weight for month 4, by 0.90, the factor for month 5 ($34 \times 0.90 = 30.6$). Her estimated milk weight for month 5 is 30.6 pounds. If the test-day weight is not available for either the fifth or sixth months, the weight for month 6 can be obtained in like manner. To obtain this weight, the estimate for month 5 may be employed: multiply 30.6, the estimate for month 5, by 0.89, the factor for the sixth month ($30.6 \times 0.89 = 27.2$).

An example using the *succeeding* test-day record follows:

Assume that on the first test-day a milk weight was lost, or the cow was used as a nurse cow. A milk weight of 62 pounds was obtained on the second test-day. To obtain the milk weight for month 1, multiply 62, the milk weight for month 2, by 0.95, the factor for month 1 ($62 \times 0.95 = 58.9$). Her estimated milk weight for month 1 is 58.9 pounds. This procedure applies to any period in the lactation when an unknown weight is followed by a known weight.

An example using test-day records preceding and succeeding a missed record:

Assume that a cow produces 57 pounds of milk on test day in month 5, her milk weight is lost in month 6, and she produces 46 pounds in month 7. The test-day production for months 5 and 7 should be added and the sum multiplied by the factor for month 6, column 3 ($57 + 46 = 103$; $103 \times 0.51 = 52.5$ pounds of milk estimated for month 6).

Estimating Production for Months 11 and 12

It is suggested that, if production estimates are desired for months 11 and 12, the production for month 10 (estimated or actual) be reduced by 10 percent as an estimate of production for month 11. The production for month 11 (estimated or actual) should be reduced by 10 percent to estimate production for month 12.

TABLE 5.—*Calculating age in months*

Year	Jan. (1)	Feb. (2)	Mar. (3)	Apr. (4)	May (5)	June (6)	July (7)	Aug. (8)	Sept. (9)	Oct. (10)	Nov. (11)	Dec. (12)	Year
75	301	302	303	304	305	306	307	308	309	310	311	312	75
74	289	290	291	292	293	294	295	296	297	298	299	300	74
73	277	278	279	280	281	282	283	284	285	286	287	288	73
72	265	266	267	268	269	270	271	272	273	274	275	276	72
71	253	254	255	256	257	258	259	260	261	262	263	264	71
70	241	242	243	244	245	246	247	248	249	250	251	252	70
69	229	230	231	232	233	234	235	236	237	238	239	240	69
68	217	218	219	220	221	222	223	224	225	226	227	228	68
67	205	206	207	208	209	210	211	212	213	214	215	216	67
66	193	194	195	196	197	198	199	200	201	202	203	204	66
65	181	182	183	184	185	186	187	188	189	190	191	192	65
64	169	170	171	172	173	174	175	176	177	178	179	180	64
63	157	158	159	160	161	162	163	164	165	166	167	168	63
62	145	146	147	148	149	150	151	152	153	154	155	156	62
61	133	134	135	136	137	138	139	140	141	142	143	144	61
60	121	122	123	124	125	126	127	128	129	130	131	132	60
59	109	110	111	112	113	(114)	115	116	117	118	119	120	59
58	97	98	99	100	101	102	103	104	105	106	107	108	58
57	85	86	87	88	89	90	91	92	93	94	95	96	57
56	73	74	75	76	77	78	79	80	81	82	83	84	56
55	61	62	63	64	65	66	67	68	69	70	71	72	55
54	49	50	51	52	53	54	55	(56)	57	58	59	60	54
53	37	38	39	40	41	42	43	44	45	46	47	48	53
52	25	26	27	28	29	30	31	32	33	34	35	36	52
51	13	14	15	16	17	18	19	20	21	22	23	24	51
50	1	2	3	4	5	6	7	8	9	10	11	12	50

Example:

Birth date	*8–15–54*
Calving date	*6–12–59*
Locate year-month of calving date	114
Locate year-month of birth date, and subtract	56
	58

TABLE 6.—*Year-day table*

[The difference between 2 dates can be determined by subtracting the year day of the 1st date from the year day of the 2d date. If the dates occur in different years, use the year day on the right half of the table for the last date. In leap year add 1 day for dates occurring after Feb. 28. If dates are to be inclusive, add 1 day.]

	1 Jan.	2 Feb.	3 Mar.	4 Apr.	5 May	6 June	7 July	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.	1 Jan.	2 Feb.	3 Mar.	4 Apr.	5 May	6 June	7 July	8 Aug.	9 Sept.	10 Oct.	11 Nov.	12 Dec.	
1	1	32	60	91	121	152	182	213	244	274	305	335	366	397	425	456	486	517	547	578	609	639	670	700	1
2	2	33	61	92	122	153	183	214	245	275	306	336	367	398	426	457	487	518	548	579	610	640	671	701	2
3	3	34	62	93	123	154	184	215	246	276	307	337	368	399	427	458	488	519	549	580	611	641	672	702	3
4	4	35	63	94	124	155	185	216	247	277	308	338	369	400	428	459	489	520	550	581	612	642	673	703	4
5	5	36	64	95	125	156	186	217	248	278	309	339	370	401	429	460	490	521	551	582	613	643	674	704	5
6	6	37	65	96	126	157	187	218	249	279	310	340	371	402	430	461	491	522	552	583	614	644	675	705	6
7	7	38	66	97	127	158	188	219	250	280	311	341	372	403	431	462	492	523	553	584	615	645	676	706	7
8	8	39	67	98	128	159	189	220	251	281	312	342	373	404	432	463	493	524	554	585	616	646	677	707	8
9	9	40	68	99	129	160	190	221	252	282	313	343	374	405	433	464	494	525	555	586	617	647	678	708	9
10	10	41	69	100	130	161	191	222	253	283	314	344	375	406	434	465	495	526	556	587	618	648	679	709	10
11	11	42	70	101	131	162	192	223	254	284	315	345	376	407	435	466	496	527	557	588	619	649	680	710	11
12	12	43	71	102	132	163	193	224	255	285	316	346	377	408	436	467	497	528	558	589	620	650	681	711	12
13	13	44	72	103	133	164	194	225	256	286	317	347	378	409	437	468	498	529	559	590	621	651	682	712	13
14	14	45	73	104	134	165	195	226	257	287	318	348	379	410	438	469	499	530	560	591	622	652	683	713	14
15	15	46	74	105	135	166	196	227	258	288	319	349	380	411	439	470	500	531	561	592	623	653	684	714	15
16	16	47	75	106	136	167	197	228	259	289	320	350	381	412	440	471	501	532	562	593	624	654	685	715	16
17	17	48	76	107	137	168	198	229	260	290	321	351	382	413	441	472	502	533	563	594	625	655	686	716	17
18	18	49	77	108	138	169	199	230	261	291	322	352	383	414	442	473	503	534	564	595	626	656	687	717	18
19	19	50	78	109	139	170	200	231	262	292	323	353	384	415	443	474	504	535	565	596	627	657	688	718	19
20	20	51	79	110	140	171	201	232	263	293	324	354	385	416	444	475	505	536	566	597	628	658	689	719	20
21	21	52	80	111	141	172	202	233	264	294	325	355	386	417	445	476	506	537	567	598	629	659	690	720	21
22	22	53	81	112	142	173	203	234	265	295	326	356	387	418	446	477	507	538	568	599	630	660	691	721	22
23	23	54	82	113	143	174	204	235	266	296	327	357	388	419	447	478	508	539	569	600	631	661	692	722	23
24	24	55	83	114	144	175	205	236	267	297	328	358	389	420	448	479	509	540	570	601	632	662	693	723	24
25	25	56	84	115	145	176	206	237	268	298	329	359	390	421	449	480	510	541	571	602	633	663	694	724	25
26	26	57	85	116	146	177	207	238	269	299	330	360	391	422	450	481	511	542	572	603	634	664	695	725	26
27	27	58	86	117	147	178	208	239	270	300	331	361	392	423	451	482	512	543	573	604	635	665	696	726	27
28	28	59	87	118	148	179	209	240	271	301	332	362	393	424	452	483	513	544	574	605	636	666	697	727	28
29	29	-----	88	119	149	180	210	241	272	302	333	363	394	-----	453	484	514	545	575	606	637	667	698	728	29
30	30	-----	89	120	150	181	211	242	273	303	334	364	395	-----	454	485	515	546	576	607	638	668	699	729	30
31	31	-----	90	-----	151	-----	212	243	-----	304	-----	365	396	-----	455	-----	516	-----	577	608	-----	669	-----	730	31

Examples for Use of Table 6

In using table 6, determine the difference between two dates by subtracting the year-day of the first date from the year-day of the second date. If dates are to be inclusive, add one day.

Examples

Calculate days on test:	
Year-day end of test period	73
Subtract year-day entered herd	60
	13
Add 1 day (inclusive dates)	1
Days on test	14
Year-day cow left herd	96
Subtract year-day start of test period	78
	18
Add 1 day (inclusive dates)	1
Days on test	19
Calculate days in milk:	
Year-day end of test period	73
Subtract year-day calving date	50
	23
Substract 2 more days for colostrum	2
Days in milk	21
The above example more fully explained:	
For a cow freshening Feb. 19, with a testing period Feb. 15 through Mar. 14.	
Last day of testing period (Mar. 14)	73
Subtract calving date (Feb. 19)	50
	23
Since days in milk start with the 4th day after calving, counting the day of calving as the 1st day, Feb. 21 and 22 are also dry days.	
Subtract	2
Days in milk	21
Calculate days carried calf:	
Year-day 305-day lactation ended	350
Subtract year-day last bred	130
Days carried calf	220
Calculate days dry:	
Year-day calving date	220
Subtract year-day dry date	160
	60
Add 1 day (inclusive dates)	1
Add 2 more days colostrum	2
Days dry	63
The above example more fully explained:	
Year-day calving date (Aug. 8)	220
Subtract year-day dry date (June 9)	160
	60
Since both dry date and calving date are considered dry dates, 1 day is added for inclusive dates.	
Add	1
	61
The days in milk do not start until the 4th day after calving, counting the calving date as the 1st day; therefore, 2 more days (the 2nd and 3rd days after calving) are considered dry days.	
Add	2
	63

Explanation of a DHIA Sire Record Form—DHIA-1202

The USDA–DHIA Sire Summary Record may be used to appraise a sire's breeding value for production by comparing his daughters' production to that of the herdmates of the daughters. Herdmates (often called contemporaries or stablemates) are defined as cows that calve in the same herd, year, and season as the daughter in question, excluding any of her paternal sisters.

The herdmates comparison is useful because it removes from the evaluation of breeding value, complications arising from herd, year, and season of freshening variations in production.

Herd-year-seasons are based on a 5-month moving average. The appropriate average for the record of a daughter of a sire is obtained by averaging the records of daughters of other sires calving in the herd in the same month as the daughter, in the previous 2 months, and in the succeeding 2 months. For example, the herdmate average for a daughter of the sire calving in March would be obtained by averaging the production of nonpaternally related cows calving in that herd from January through May.

A USDA–DHIA Sire Summary Record contains all usable records reported for daughters of the sire, along with the average production of all available herdmates. All records used are on a 305-day lactation, mature-equivalent, twice-a-day milking basis. When production records for more than one lactation are available for a daughter, her record is based on the average of all her usable, standardized, 305-day lactation records. Records that are incomplete because they were terminated by sale, death, abortion, or discontinuance of test are extended to a 305-day basis. All incomplete records are used in compiling the daughter's average production and the average production of her herdmates.

At the top of the Sire Summary Record is the identification number of the sire, together with his name, birthdate, and the identification of his sire and dam. When a summary record is compiled for a sire for the first time, only the sire number is available.

In the body of the Sire Summary Record are compilations of data included in the evaluation. These data are summarized to show separately non-AI daughter comparisons and AI daughter comparisons. A non-AI sire evaluation based on 5 to 9 comparisons and an AI evaluation based on 10 to 24 comparisons are considered "preliminary."

Preliminary evaluations should be considered only as an indication and not as conclusive evidence of the breeding value of a sire. In general, the greater the number of daughter-herdmate comparisons included in an evaluation, the more reliable the evidence of the sire's breeding value. However, if a non-AI evaluation contains 17 or more unselected comparisons and an AI evaluation contains 50 or more unselected comparisons, additional data will seldom markedly affect the summary.

In the use of the daughter-herdmate comparison procedure, the desirable sire is that which markedly increases the production of his daughters over that of their herdmates. This is because the sire's daughters are compared to other cows that experienced the

same management and feeding conditions as did the daughters. In other words, the daughters and their herdmates had an equal opportunity to produce. The difference in production between a sire's daughters and their herdmates is roughly the same from one level of herd production to another. Generally, a sire with a markedly negative daughter-herdmate comparison should not be expected to raise the production level of a herd.

Additional Facts Helpful

Production data for the daughters and their herdmates should be supplemented by additional information gathered from the herd(s) in which the daughters made their records. In the column headed "CAR" (Conditions Affecting Record) are listed codes for conditions that have affected the records of individual cows. Further information on such records should be obtained from the owner's herd record book.

In addition, a personal evaluation of the herd management and feeding conditions in a herd where a daughter or group of daughters made their records is often useful. Also, elements of the type of the sire's daughters, such as udder attachment, feet and legs, should be evaluated.

Numbered Headings on DHIA–1202

1. AI Service.—If a sire has been in AI service, the code numbers of the State and stud are listed. The first two digits of the code refer to the State in which the stud is located. The second two digits refer to the code number of the stud within the State.

2. Records from States.—Data under this heading indicate the States from which records of daughters included in the sire summary record were made, together with the number of daughters from each State. The first two digits indicate the State; the last three digits indicate the number of daughters from the State.

3. Summary.—Data in the top portion of this column refer to the total number of daughters with records available for tabulation, and the number of daughters which had one or more records with corresponding herdmate data available. The bottom portion of the column under the subhead "Herd Code" contains the herd code number of the herd from which production records of the daughters were reported.

4. AI.—The letter "A" in this column indicates the daughter is an AI offspring.

5. Breed.—Breed of the daughter is indicated by one of the following codes:

1—Ayrshire	4—Jersey	7—Red Dane
2—Guernsey	5—Brown Swiss	8—Other
3—Holstein	6—Milking Shorthorn	9—Red Poll

6. CAR (Conditions Affecting Record).—Conditions affecting the record are indicated by the following codes:

1—Estimated	3—Incomplete; died	7—Sickness
2—Incomplete; sold	4—Injury	8—Abortion
		9—Nurse Cow

7. Adjusted herdmate average.—As mentioned previously, the herdmate average is the average production of nonpaternally related cows that calve in the same herd and year and within 2 months before or 2 months after the daughter in question. Since the reliability of this measure of herd management and feeding depends on the number of herdmates, the following procedure is required to standardize for number of herdmates:

$$\text{Adj. Herdmate Av.} = \text{Breed Season Av.} + \frac{M}{M+1}(\text{Herdmate Av.} - \text{Breed Season Av.}),$$

where M is the number of herdmates.

The breed-season averages are calculated from the nationwide 305-day 2X–ME DHIA lactation averages for cows of the breed in question that calved in the preceding 5 years.

In the column "Records Number," the number listed is the average number of herdmates per daughter.

The first number on the column "Milk Pounds" is the average of the Adjusted Herdmate Averages for milk production of all daughters. The second number is the average milk production of all daughters with herdmates minus the Adjusted Herdmate Average. The entries under the subhead "Fat pounds" apply to the corresponding values for fat production.

8. Predicted average.—For all AI sires, an additional criterion of breeding value is calculated from the daughter-herdmate comparisons of their AI offspring. The Predicted Average is an estimate of the producing level of future AI daughters of the sire. In this measure, the sire's evaluation is adjusted for levels of herds in which the daughters produce, and for the number of daughters. The calculations are in two steps:

1. A=Daughter Av.—0.9 (Adj. Herdmate Av. —Breed Av.)
2. Predicted Av.=Breed Av.+$\frac{N}{N+12}$ (A—Breed Av.), where N is the number of daughters.

The breed average, calculated from nationwide DHIA lactation averages of the previous 5 years, can be found in the USDA–DHIA Sire Summary List.

Retabulation of Sire Data

In each sire summary tabulation, all USDA–DHIA Sire Summary Records are brought up to date if sufficient additional data are available to add significantly to the reliability of the sire record.

A DHIA sire summary record is retabulated when there are 50 percent more comparisons available than were included in the previous summary.

Daughter Listings

Data for all daughters of non-AI sires are listed. Registered daughters of AI sires are screened and those meeting a requirement on milk production are listed.

The screening process is carried out on the milk entry under the subhead "WTD DIFF" (Weighted Difference). This value is calculated for each daughter as follows:

$$\text{WTD DIFF}=\frac{N}{1+(N-1)(0.45)}(\text{Daughter's Av.}-\text{Adj. Herdmate Av.})$$

In the example, N is the number of records that the daughter has. All registered daughters of AI sires whose "WTD DIFF" value for milk is greater than 1½ standard deviations are listed. This point was chosen to allow the listing of the best 7 percent of AI cows.

USDA-DHIA SIRE SUMMARY RECORD FOR HOLSTEIN (BREED)

U. S. DEPT. OF AGRICULTURE · AGRICULTURAL RESEARCH SERVICE
ANIMAL HUSBANDRY RESEARCH DIVISION · DAIRY CATTLE RESEARCH BRANCH

1276888 (SIRE NUMBER) MAVIEW CARROLL DIRECT HEARTY..... (NAME) RECORDS FROM STATES [2] 21-002,23-089

BORN. 04-06-56 SIRE. 928378 DAM. 2874902

AI SERVICE [1] 23-04 TABULATED 08-63 PREVIOUS TABULATION. 08-62

SUMMARY [3]	IDENTIFICATION OF DAUGHTERS OF SIRE							AVERAGE RECORDS OF DAUGHTERS OF SIRE						ADJUSTED HERD-MATES AVERAGE [7]			PREDICTED AVERAGE [8]	
	AI [4]	DAUGHTER NUMBER	DAM NUMBER	BREED [5]	DATE OF BIRTH MO.	DA.	YR.	DAYS IN MILK NUMBER	RECORDS AVERAGED NUMBER	MILK POUNDS	FAT PERCENT	FAT POUNDS	CAR [6]	RECORDS NUMBER	MILK POUNDS	FAT POUNDS	MILK POUNDS	FAT POUNDS
90 AI DAUGHTERS									99	13444	3.8	510						
87 DAU WITH HERDMATES									95	13458	3.8	511		12	13160	491	12483	466
														DIFF.	298	20		
1 NON AI DAUGHTERS									1	15030	4.0	603						
1 DAU WITH HERDMATES									1	15030	4.0	603		18	14829	598		
														DIFF.	201	5		
HERD CODE																	WTD.	DIFF.
23570060	A	4892827	2988599	3	2	2	59	305	1	15880	3.6	568		1	11442	427	4438	141
23640023	A	4860340	3454570	3	12	22	58	296	1	16860	3.4	568		19	13179	495	3681	73
23360293	A	4723803	3788765	3	5	14	58	305	1	18800	4.0	755		10	14037	500	4763	255
23360446	A	5544849	3926716	3	7	21	58	305	1	16500	3.4	557		10	11052	423	5448	134
23080058	A	5161453	4324042	3	12	1	58	305	1	19410	3.8	743		10	15195	578	4215	165

FIGURE 1

DHIA FORM 1202 (2 62)

SUPERVISOR'S WORK SHEET FOR CALCULATING LACTATION RECORDS

Barn Name ROSNI

Item						
1.	Date fresh	Year 51	Month 8 → 7	Day 28 → 54
2.	Date born	Year 49	Month 1	Day 26
3.	Age	Years 2	Months 6	Days 28

PRODUCTION SINCE FRESH	Days in milk (number	Milk (pounds)	Fat (pounds)
4. Total production for testing year	304	7240	243
5. Total-to-date before freshening	115	2380	78
6. Item 4 minus item 5	189	4860	165
7. Adjustment for change in centering date (+ or -)	—	None	—
8. Production since fresh (Items 6 + 7)	189	4860	165

COMPLETE LACTATION RECORD

1. Production since fresh	223	7790	265
2. Total-to-date before freshening	115	2380	78
3. Complete lactation (Items 1 + 2)	338	10170	343

FIRST 305 DAYS OF LACTATION

1. Production since fresh	223	7790	265
2. Last total-to-date before end of 305 days	61	1340	44
3. Adjustment from next testing period to make 305 days	21	(21 x 23.0) 480	(480 x 3.1) 15
4. First 305 days of lactation (Items 1 + 2 + 3)	305	9610	324

FIGURE 2

Interpretation and Use of Error Codes for Lactation Records on Form DHIA-1060

Lactation records listed on Form DHIA–1060 have been subjected to extensive auditing of DHIA lactation data reported by the States. This auditing is carried out by electronic computing equipment to assure complete and thorough screening of data to be used in sire evaluation. The records are listed in herd sequence and returned to the office of the State Extension Dairyman.

It is requested that each record be checked for validity, not only on the particular field indicated by the error code, but on *all* other fields as well. Frequently two or more errors are present, but an error code indicates only the first error or conflict encountered.

Supervisors should make the appropriate corrections (or mark "correct") on each record and return the lists to the State Extension Dairyman for forwarding to the Dairy Cattle Research Branch, USDA.

Many records on these lists are correct. When an incoming record on a cow contains data which conflict with previously received data on that animal, *all* records of the cow are removed and coded with the error code indicating the nature of the conflict. Records marked with an (*) in the right margin are records reported in previous years.

Records verified or corrected by the State will be punched and reentered into the Master Lactation File for use in sire evaluation. At the present time, for every 100 new records received, 9 new or master file records are removed due to errors or conflicts.

Alphabetic codes are listed below with an explanation of the probable errors, together with a suggested action for correction:

Code	*Interpretation*	*Suggested action*
A	*Registered Sire Number* 1. Sire number conflicts with previous data; or 2. Sire number invalid according to Breed Association records; or 3. Registered cow—sire number lacking or coded as eartag.	Give correct registration number of sire or mark as correct.
B	*Dam Number* 1. Dam number conflicts with previous data; or 2. Dam number invalid according to Breed Association records; or 3. Registered cow—dam number lacking or coded eartag; or 4. Alphabetic characters in registration number.	Give correct identification number of dam or mark as correct.
C	*Identification Number (Cow, Sire, or Dam)* 1. Alphabetic characters or blanks present	Give correct identification number or mark as correct.
D	*Birthdate* 1. Contains blanks or alphabetic characters; or 2. Registered cow-year and/or month zero; or 3. Month greater than 12, or day greater than 31; or 4. Conflict with previously reported birthdate.	Give correct date of birth or mark as correct.
E	*Breed* 1. Registered cow with breed "8" code; or 2. Breed of sire zero; or 3. Registered dam with zero breed; or 4. Registered cow, sire, and dam breeds differ.	Give correct breed code of animal.
F	*Possible Twin* 1. Sire and dam equal for 2 different cows, birthdates less than 9 months apart; or 2. 2 or more daughters of same dam with equal birthdates.	Verify or correct cow number, dam number, and birthdate.
G	*Herd Code* 1. State code zero or invalid; or 2. Must not be zero if cow born after 10–59 3. Eartag cow, sire, or dam with invalid State code in identification number.	Give correct Herd Code.
H	*Conflict in Identification Number (Cow, Sire, or Dam)* 1. Dam number higher than cow number; or 2. Conflicting sire and/or dam numbers for 2 or more records of same cow.	Check identification of cow, sire, and dam.
I	*Registration Number (Cow)* 1. Cow number invalid according to Breed Association data; or 2. Canadian registration code for breeds higher than "4".	Check all indentification data.
J	*Equal Identification Numbers* 1. Cow number same as dam or sire; or 2. Dam number same as sire number.	Check all identification numbers.
M	*Eartag Identification* 1. Private eartag number; or 2. Disease tag for cow born later than 1–57.	Verify eartag numbers.
O	*Conflicting Corrections—Identification Verified* 1. Two verified records with same cow, sire, and dam differ in birthdate data.	Verify or correct complete identification.
P	*Lactation Data* 1. Contains alphabetic characters or blanks	Give correct lactation data.

Code	Interpretation	Suggested action
Q	*Calving Data* 1. Month zero or greater than 12; or 2. Days greater than 31; or 3. Age at calving less than 14 months; or 4. Year zero; or 5. Less than 9 months between lactations; or 6. Calving date conflicts with current date; or 7. Conflicting reports—equal calving dates, unequal production.	Verify or correct calving date.
R	*Percent Test* 1. Complete lactation: test outside high and low limits for breed; or 2. Incomplete lactation: less than 2.4 or higher than 7.3.	Verify milk, butterfat, and breed.
S	*Conflicting Corrections—Production* 1. 2 records submitted for same lactation—both coded as production corrections.	Verify or correct production data.
T	*Production* 1. Conflicting reports for same calving date—equal production, 1 record coded 3x, 1 record coded 2x; or 2. Zero milk or fat or milk greater than 45,000 or fat greater than 1,800 pounds.	Verify or correct calving date, days 3x, and production data.
V	*Days in Milk* 1. Days milked 3x exceeds days milked	Verify or correct days milked, days 3x.
W	*Identification Conflicts With Breed Association Data*	Verify or correct identification data.
X	*More than 20 lactations* for same cow	Check identification and lactation data.
Y	(For use of USDA Office only)	No action required.

Interpretation and Use of Error Codes for Yearly Herd Data on Form DHIA-1080

Yearly herd reports (780's, 781's, 205–9's, or 1105's) containing apparent errors, conflictions, or omissions are listed by the computer on Form DHIA–1080 and returned to the State extension dairyman. The source cards and the punched cards for such reports are also being returned so that all can be forwarded to the supervisors for review and correction where appropriate.

Alphabetic codes listed in the remarks column indicate the reason or reasons for which the record was rejected. The record is listed with asterisks appearing over the fields questioned. The entire record should be checked, however, to see that no other errors are present.

PLEASE NOTE:

The yearly herd reports listed were rejected for the "apparent" reasons indicated by the alphabetic codes. It is possible that the record as listed may be correct. It may have been rejected because some part of the data was beyond the limits established for the machine edit.

If cow-years, milk and fat, SNF, and/or protein figures appear to be correct, these data have been placed in file as an incomplete record (production data only) and used as such in the yearly herd summaries.

Code	Field in question	High limit	Low limit
A	**Rate of Forage Feeding*		
B	**Milk Pounds*		
	***Milk Pounds (3x)*		
	**Fat Pounds*		
	***Fat Pounds (3x)*		
	**Fat Percent by Breed*		
	Ayrshire		
	Guernsey		
	Holstein		
	Jersey		
	Brown Swiss		
	Milking Shorthorn		
	Red Dane		
	Mixed or unknown		
	Red Poll		
	**Protein Pounds*		
	***Protein Pounds (3x)*		
	**Protein Percent*		
	**SNF Pounds*		
	***SNF Pounds (3x)*		
	**SNF Percent*		
C	***CWT. Succulent Forage*		
D	**Cost of Concentrates per CWT*		
	or		
	Cost of Concentrates higher than Total Feed Cost		
	or		
	No Cost given for Concentrates reported		
	or		
	No Concentrates given for cost reported		
E	**Value of Product*		
F	**Feed Index*		
G	***CWT. Concentrates*		
H	***CWT. Dry Forage*		
J	***Days on Pasture*		366
K	*Blank or nonnumeric character in record.* (May be used as incomplete record.)		
L	*1105 Card No. 2 only.* (First part of record missing—Card No. 1)		
M	*Duplicate report* (One record put in file)		
N	*Invalid character in herd, year, or month*		
	or		
	Invalid State Code		
P	*Feed Cost exceeds Value of Product by more than $50*		
Q	**Feed Cost Per CWT. of Milk*		
X	*Old record*—testing year *prior* to May of current year minus 3		
	or		
	Testing year after April of current year		
Y	*Zeros in required fields* (except as indicated by Z)		Record used as incomplete
Z	*Zero cow-days* or *cow-years on test*		Record not used
	or		
	Less than one cow-year		
	or		
	More than 730,000 cows-days (2,000 cow-years) on 1105		
	or		
	Zero Milk Pounds		
	or		
	Zero Fat Pounds		

*High and low limits are set.
**High limits are set.

NOTE.—High and low limits are subject to change. They will be sent to you each year. (No change for item J.)

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Ten Points for DHIA Supervisors

1. On your first visit to a farm, make it a point to get acquainted. Favorable first impressions go a long way toward obtaining the cooperation that will help to make your services most useful. Do not talk too much. Be a good listener. Be helpful, but do not put yourself forward.

2. Help; don't hinder. Fit yourself into the mode of living on each farm you visit. Your visit should cause the least possible disturbance to the family's normal living habits.

3. Spend the evening with the dairyman and his family if it is convenient for them to have you do so. If the association operates a central testing laboratory and you do not stay overnight with the dairyman, spend as much time as possible with the dairyman while you are visiting the farm. You can learn much from him and he may learn something from you.

4. Be pleasant and agreeable, but do not carry gossip.

5. Mix praise with helpful criticism in such a way that the dairyman will gladly follow your advice. The best way is to lead up to an idea in such a manner that the dairyman himself will be the first to mention the need for and method of improvement.

6. Keep yourself informed on the new phases of your work. Discoveries are being made continually, and new methods are being developed for conducting a dairy herd improvement program. You should have the latest information at all times.

7. Complete your work and be sure that all records are up to date at each visit. Records that are not complete or are not up to date are not of maximum value to the owner. If your record work is in arrears, the dairyman may justifiably think you are not capable of handling your job.

8. Promote cooperation among your dairymen, but do not make yourself conspicuous.

9. Publish favorable results and give each dairyman and each herd as much publicity as the facts will warrant.

10. Dairy herd improvement association work is an agricultural extension project. It is a part of the local county agent's extension program. The county agent can help you, and you can be of assistance to him. If at all possible, visit his office and talk over your work with him at least once a month.

B

CONIFER NURSERY PRACTICE *in the* PRAIRIE-PLAINS

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CONIFER NURSERY PRACTICE in the PRAIRIE-PLAINS

By J. H. Stoeckeler, principal soil scientist, Lake States Forest Experiment Station (maintained by the U.S. Department of Agriculture in cooperation with the University of Minnesota), and P. E. Slabaugh, principal silviculturist, Lake States Forest Experiment Station (stationed at Bottineau, N. Dak.).

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ACKNOWLEDGMENT

Forest nursery practices for the Prairie-Plains have developed through research and the resourcefulness of nurserymen engaged in the production of planting stock. The 50 years of experience gained in conifer propagation at the Bessey Nursery in the Nebraska National Forest has provided the greatest single contribution to this handbook, and special gratitude is due M. K. Meines, the present superintendent. Other Federal nurseries supplying material were operated by the Soil Conservation Service, by the Prairie States Forestry Project (discontinued in 1942), and by the then Bureau of Plant Industry (now the Agricultural Research Service). Much assistance was received from State and commercial nurserymen, including Albert Engstrom, Norman, Okla.; John Molberg, Bottineau, N. Dak.; Lloyd Moffett and J. R. Weir, Fremont, Nebr.; and Clarence Jensen, Esmond, N. Dak.

CONTENTS

	Page
Introduction	1
Native conifers	1
History of conifer planting	4
Future of conifer planting	5
Collection and handling of seed	6
Importance of seed source	6
Seed collection zones and localities	7
Selection of individual stands and trees	8
Determination of seed ripeness and quality	8
Seed crop frequency	9
Seed yields	9
Methods of seed collection	11
Care of fresh seed	13
Seed extraction and cleaning	13
Seed storage	15
Seed testing	15
Seed dormancy and pretreatment	17
Selection of the nursery site	18
Soil	18
Water supply	19
Availability of markets, utilities, and labor	19
Shape, topography, and size of tract	20
Crop history of land	20
Development of the nursery site	21
Subdividing the nursery	21
Developing the irrigation system	21
Seedbed preparation and sowing	24
Staking out and preparing the beds	24
Computing the amount of seed to sow	25
Time of seeding	26
Broadcast versus drill sowing	27
Seeding equipment	27
Covering the seed	28
Seedbed care during germination and the seedling stage	31
Half-shade	31
Soil moisture and irrigation	32
Weed control	34
Mechanical and hand weeding	34
Chemical control of weeds	34
Mineral spirits	34
Methyl bromide	35
Allyl alcohol	35
Miscellaneous chemicals	35
Possible harmful effects of chemicals on trees and soil	36
Transplanting	36
Hand transplanting	36
Mechanical transplanting	37
Transplant spacing	38
Transplant losses	38
Season of transplanting	40
Top and root pruning	40
Hardening-off	41
Digging, grading, packing, storing, and shipping	42
Digging nursery stock	42
Grading	43
Packing	44
Storing and shipping	46
Potting and balling nursery stock	48
Age classes of stock needed for the Plains	50
Inventory	55
Soil management	57
Fertility requirements and the determination of nutrient needs	57
Visual symptoms of malnutrition	57
Fertilizer applications and their results	59
Liquid fertilizers as topdressings	60
Manure, compost, leaf mold, and peat	61
Cover and soil improvement crops	62
Maintenance of proper pH	62
Comparison of acidification with different chemicals	63
Carryover effect of acidification	66
The role of mycorrhizal fungi	67
Nursery protection	70
Meteorological factors	70
Wind	70
Heat	71
Frost and winter damage	73
Nursery insects and mites	74
White grubs	75
Nantucket pine tip moth	75
Red spiders	76
Wireworms	76
Cutworms	76
Grasshoppers	76
Nursery diseases	77
Damping-off	77
Cedar blight	78
Rusts	79

Nursery protection—Continued	Page
Nursery diseases—Continued	
Nematodes	79
Dieback	79
Root rots	79
Mammals and birds	80
Literature cited	81
Appendix	89
Common and scientific names of trees and shrubs mentioned	89
Safety rules and precautions for handling, mixing, and applying chemicals	89

Appendix—Continued	Page
Spray formulas for insecticides and fungicides	90
Mouse baits	91
Sources of information on nursery problems	92
Sources of information on nursery machinery, equipment, and chemicals	92
Requirements and procedures for nursery stock inspection in the Plains States	92
U.S. Department of Agriculture forest tree seed policy (1939)	93
Where to purchase seed	93

INTRODUCTION

The Prairie-Plains occupy a broad belt of highland between the Rocky Mountains and the Central Lowland. The region extends from San Antonio, Tex., to about Edmonton, Alberta, and Saskatoon, Saskatchewan. Included are the Great Plains proper, a region mostly west of 100° longitude with high altitude, semiarid climate, and short grass vegetation; and the prairie region, an area of tall grass bordering the eastern deciduous forest. In this essentially treeless area, farmers and ranchers need windbreaks to protect their buildings, livestock, and crops. Townspeople need trees along their streets and in their parks to beautify their cities and to provide shade.

Tree planting began in the Prairie-Plains just after the first settlers arrived. Many problems of tree establishment confronted the early planters. These included low annual precipitation, frequent high winds, unfavorable soils, and lack of knowledge concerning the adaptability of tree species to Plains conditions.

Over the years, from research and practical experience, many of the difficulties have been gradually overcome. For example, information is now available on what species to plant and how to plant and maintain the trees.

The growing success of tree planting has increased the demand for deciduous and coniferous planting stock. Meeting that demand will require the best nursery practice that experience and research can provide.

This manual summarizes available information on Plains conifer nursery practice and recommends to nurserymen specific methods for nursery stock production. It will supplement but not replace a bulletin published in 1941, "Nursery Practice for Trees and Shrubs Suitable for Planting on the Prairie Plains" (U.S. Dept. Agr. Misc. Pub. 434), a publication concerned primarily with deciduous stock production.

Some operations are fairly standardized, while others allow the nurseryman more choice of methods to fit his own situation. Both mechanized and hand methods required in producing trees are presented. Greatest emphasis is on methods suited to large-scale production. Manually operated devices, many developed by the large nurseries during mechanization, are described to meet the needs of small nurseries.

NATIVE CONIFERS

The natural stands of trees and shrubs in the Prairie-Plains are outliers of the Rocky Mountain forests on the west and of the Lake States, Central, and Southern forests on the east. Though their acreage, distribution, and number of species are not great, these stands have been important in reforestation in the Prairie-Plains because they have provided a source of seed from plants adapted for growing in this region.

Some conifers in the Prairie-Plains, such as ponderosa pine, eastern redcedar, and Rocky Mountain juniper, are distributed widely (fig. 1).[1] Others, such as pinyon, limber pine, lodgepole pine, white spruce, and blue spruce, have more limited distribution. Most of this natural growth is in breaks, bluffs, and escarpments of rough topography at the higher elevations of the western Great Plains (fig. 2). The localities of the most important species are described briefly below.

[1] For scientific names of trees and shrubs discussed, see Appendix.

Authority cited and dates enclosed in parentheses, as in the caption for figure 1, refer to items in Literature Cited, p. 81.

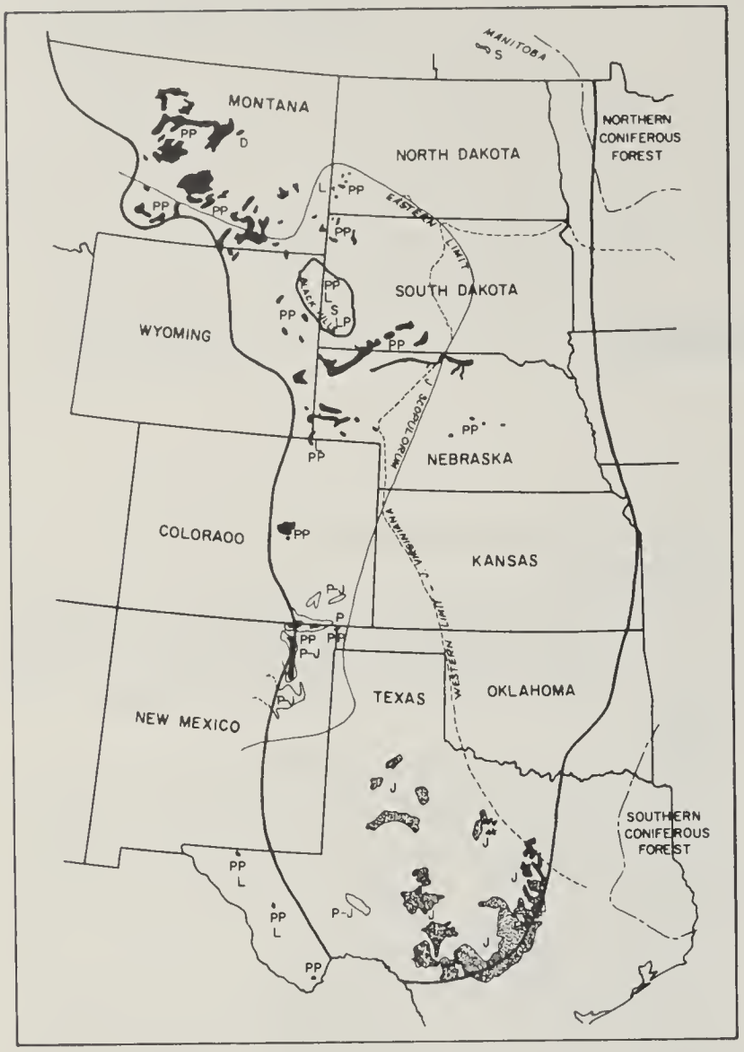

FIGURE 1.—Natural distribution of some important conifers in the Prairie-Plains. The approximate boundaries of the Prairie-Plains and the Black Hills are indicated by heavy black lines. The range of eastern redcedar (*Juniperus virginiana*) is shown by a dashed line and that of Rocky Mountain juniper (*J. scopulorum*) by a solid line. Detailed distributions are identified as follows: PP—ponderosa pine, L—limber pine, P—pinyon, LP—lodgepole pine, J—junipers other than those above, S—white spruce, and D—Douglas-fir. (Albertson 1940, Bray 1904, Cockerill et al. 1939, Curtis and Lynch 1957, Herman 1958, Hutchison and Kemp 1952, Livingston 1949, Nienstaedt 1957, Potter 1952, Stoeckeler 1952a, U.S. Forest Serv. South. Forest Expt. Sta. 1940, Ware 1936, Warner and Chase 1956, Williamson 1957, and Woodin and Lindsey 1954.)

Ponderosa pine.—Ponderosa pine is the most widely distributed of the pines. It is the main species of the Black Hills, and it is found in all of the Plains States but Kansas. At its easternmost extension in Nebraska, it appears in the canyons, on the rough stony land of the Pine Ridge escarpment, and in the Niobrara and Upper Platte River drainages. Isolated groves occurred as late as 1885 in the valleys of the Dismal, Calamus, North Loup, South Loup, Lodgepole, and Republican Rivers (Bessey 1895). In South Dakota, ponderosa pine is found in the Black Hills, in the northwest corner of the State in Harding County, and scattered over the hills of Shannon, Todd, Washabaugh, and Bennett Counties (Over 1932). It occurs in three southwestern North Dakota counties in the Badlands. In east-central Colorado, ponderosa pine extends eastward on the Platte-Arkansas Divide (Weaver and Albertson 1956). It also occurs associated with pinyon in the extreme northwest corner of Oklahoma.

Other pines.—Limber pine is found in southwestern North Dakota, the Black Hills of South Dakota, the extreme southwestern corner of Nebraska, southeastern Wyoming, and the adjoining portions of Colorado. Pinyon occurs in northeastern New Mexico, southeastern Colorado, and northwestern Oklahoma. Lodgepole pine is found very locally in the western part of the Black Hills and in the Cypress Hills of southwestern Saskatchewan.

Some Southeastern pines, while not found in the Prairie-Plains, grow on dry situations adjacent to the region. Included are shortleaf pine in eastern Oklahoma and eastern Texas, loblolly pine in a small area of southeastern Oklahoma and in eastern Texas, and longleaf pine in eastern Texas.

Junipers.—Eastern redcedar and Rocky Mountain juniper are the juniper tree species found most commonly in the Prairie-Plains. Both range from the southern limits of the Prairie-Plains into Montana and North Dakota in the north. Eastern redcedar predominates on the east and Rocky Mountain juniper on the west. The ranges of the two species overlap in central South Dakota and central and northwestern Nebraska. An area of natural hybridization has been delineated, but the degree to which this represents the overall situation is unknown (Fassett 1944). The two species may occur in stands together. In eastern Texas, eastern redcedar is found on dry, gravelly ridges and limestone hills (Jones et al. 1932). Other juniper tree species include one-seed juniper in western Texas, New Mexico, and extreme western Oklahoma (Little 1950); Pinchot juniper in central, northwestern, and Trans-Pecos Texas and in western Oklahoma (Jones et al. 1932); alligator juniper in Trans-Pecos Texas (Jones et al. 1932); and Ashe juniper in northeastern and southern Oklahoma and on the Edwards Plateau in central Texas (Hall 1952).

Spruce.—White spruce is generally found in the valleys of the Black Hills of South Dakota. Outliers also occur in south-central Manitoba and southwestern Saskatchewan. Blue spruce has been reported in the Big Horn Mountains in south-central Montana.

Douglas-fir.—Douglas-fir occurs on the Piney Buttes (Garfield County) in eastern Montana in an area where the mean annual precipitation is about 12 inches and minimum temperatures may drop to −58° F. (Stoeckeler 1952a). Trees from this source have been used to a small extent in North Dakota plantings.

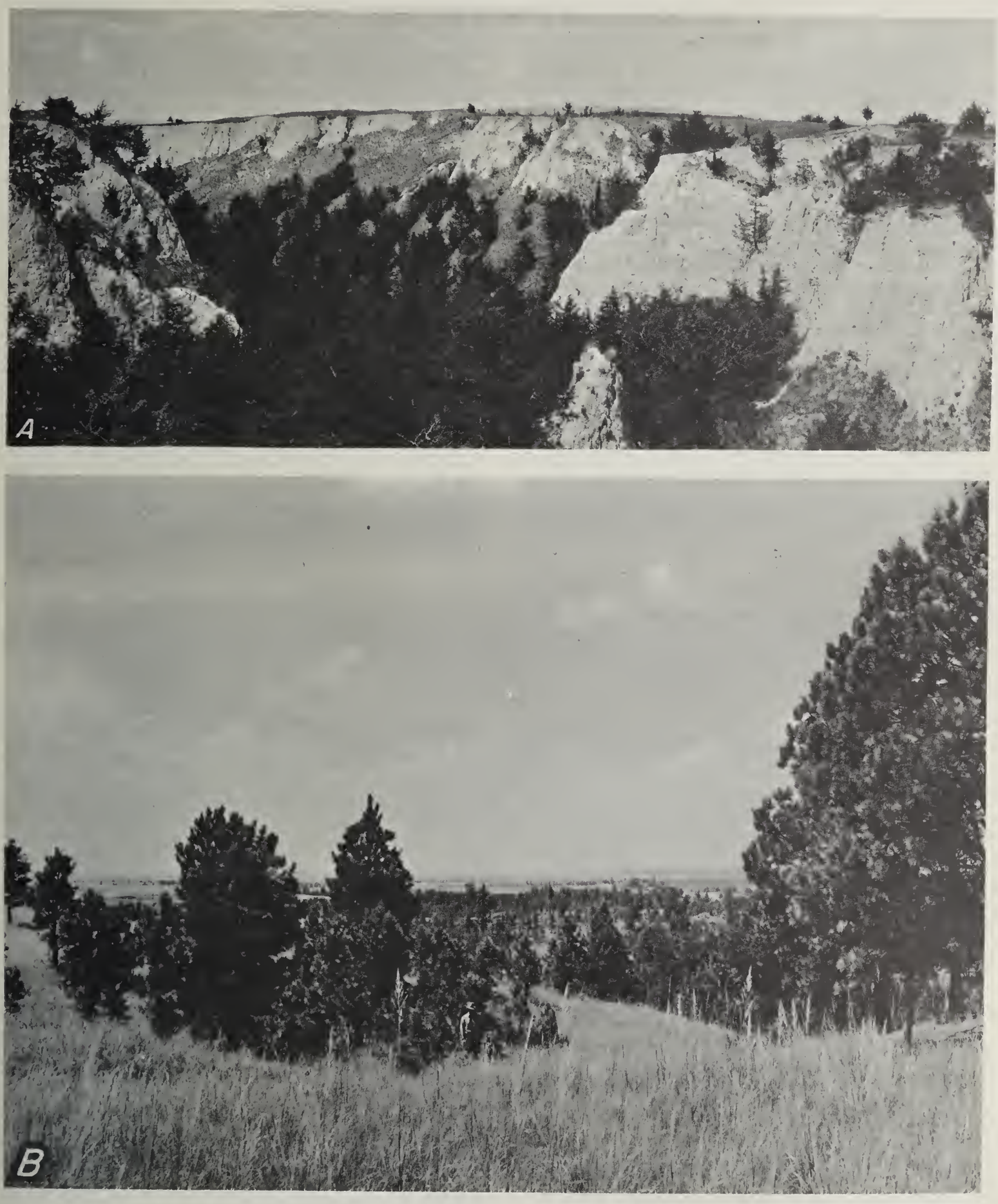

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FIGURE 2.—Natural stands of conifers in the Prairie-Plains: *A,* Eastern redcedar near Sargent, Nebr. (ponderosa pine and bur oak are associates); *B,* ponderosa pine in southwestern North Dakota on breaks of Little Missouri River. The pine has moved out into the grassland since fires have been controlled.

HISTORY OF CONIFER PLANTING

The planting of conifers for other than ornamental uses began many years ago in the Prairie-Plains. Block plantings of pine in Nebraska are recorded as early as 1873. According to the annual report of the then U.S. Division of Forestry, special efforts were made in 1898 to introduce conifers into existing plantings. Conifer nurseries had been established at several locations, and in 1898, 300,000 conifers had been distributed to farmers in quantities sufficient for 1- to 5-acre plantations. Despite these early efforts, few of the conifer plantings established before 1935 are extensive enough to allow planters to compare their performance with that of hardwoods in protection plantings. Coverage of the Plains was incomplete, and some species had little representation in some localities. A notable exception is block plantings of conifers started in 1904 on the Nebraska National Forest in the sandhills region (fig. 3).

Conifers were planted over a wide area of the Prairie-Plains by the Prairie States Forestry Project. Included in the 18,600 miles of shelterbelts planted between 1935 and 1942 under a great variety of climatic and soil conditions, these trees have been one of the main sources of information on the performance of various evergreen species in the Plains. An appraisal made in 1954 (Read 1958) of 938 shelterbelts from North Dakota to northern Texas showed that conifers, when once established, survived well throughout the survey area. Eastern redcedar was the hardiest tree. Ponderosa pine and Austrian pine showed good drought resistance and staying power despite initial survivals of less than 50 percent. Other species used by the Project were Rocky Mountain juniper, alone and with eastern redcedar, from North Dakota to Oklahoma; blue spruce and white spruce in the Dakotas; and jack pine and Scotch pine in South Dakota, Nebraska, and Kansas. Shortleaf and loblolly pines were used in the plantings of southern Kansas, Oklahoma, and Texas.

Austrian and Scotch pine have been widely planted in the Prairie-Plains. Austrian pine grows slower than ponderosa pine in Texas (Jones et al. 1932) and in Oklahoma (Afanasiev 1949a). It has been difficult to establish in North Dakota. Scotch pine has exhibited early rapid growth but is short lived and is more subject to mortality by drought.

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FIGURE 3.—This forest plantation of jack pine in the sandhills of the Nebraska National Forest was large enough by 1940 to produce posts and small poles.

Shortleaf pine has been planted in windbreaks in western Oklahoma (Afanasiev 1949b). Some loblolly pine, Japanese red pine, and Japanese black pine are used in eastern Oklahoma. Japanese black pine has been a fast grower, faster than all pines but shortleaf pine, and has a low susceptibility to tip moth damage. Japanese red pine has poor form, with multiple stems, and is highly susceptible to tip moth damage. Jack pine and eastern redcedar have been planted extensively and quite successfully in Nebraska, particularly in block plantings in the sandhill region.

Arizona cypress, a native of western Texas, New Mexico, and Arizona, has been used with great success in Texas and Oklahoma for windbreak and ornamental plantings. Trees of this species are tender while young but have withstood temperatures as cold as 10° F. when older (Jones et al. 1932). The form from central Arizona, called smooth Arizona cypress and characterized by smooth outer bark, is widely cultivated in warm, dry regions in shelterbelts and as an ornamental; it also is used for Christmas trees and fenceposts (Little 1950). Selections of oriental arborvitae are easy to establish and grow fairly fast. They have proved very hardy and effective in windbreak plantings.

FUTURE OF CONIFER PLANTING

More hardwoods than conifers have been planted in the Prairie-Plains. This was only natural. The Prairie-Plains had little native coniferous growth. Because hardwood planting stock was more available to planters and grew faster, it appealed more to the homesteader intent on securing some early protection for his farmstead. Bare-rooted conifers often dried up during transportation, and the rigorous climate limited their establishment after planting.

However, in the future, conifers will have an increasingly important place in Plains planting programs. Among their inherent advantages over most hardwoods are year-round foliage retention, greater longevity, lower fertility and soil moisture requirements, relatively more freedom from insects and diseases, and the ability after establishment to compete more successfully with weeds and grasses. Conifer needles remain under the trees, building up a vegetation-smothering and soil-protecting layer of litter that also increases water infiltration and reduces moisture evaporation. In a study of tree planting on the drier sections of the northern Great Plains, it was found that the coniferous species do not exhaust the soil moisture to as great a depth as do the hardwoods, and that they establish forest conditions very readily in reasonably full stands (George 1939).

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FIGURE 4.—Use of conifers in windbreak plantings on the Prairie-Plains: *A*, An 18-year-old planting of shortleaf pine in a field shelterbelt near Vernon, Tex.; *B*, right-angle view of a dense single-row planting of eastern redcedar, 15 years old and 18 feet high; *C*, effective year-round wind protection is provided by 25-year-old ponderosa pine in field windbreak near Towner, N. Dak.

Conifers are well adapted for all protection plantings, whether they be for farmstead, field, livestock, wildlife, or for multiple purposes (fig. 4). Not only do they provide year-round protection, but their thick crowns trap snow, and the trees offer less competition to adjacent crops (Greb and Black 1961). The soft wood has more value at maturity and is more easily disposed of than the wood of deciduous trees. Conifers are also particularly suited for ornamental plantings and for use as Christmas trees.

Conifers, of course, have some disadvantages when compared to hardwoods. It takes longer and costs more to produce planting stock. The trees are harder to establish, and because initial survivals in the field are lower, more replacements are required. Because they have a slower initial growth and consequently must compete with grass and other ground cover for a longer period, more maintenance is needed. Retention of the foliage throughout the year subjects the trees to excessive drying during periods of near dormancy. Damaging agents, such as fire or livestock, will reduce growth and may eliminate the trees since most conifers are unable to sprout or restore foliage. Reproduction of conifers other than eastern redcedar rarely occurs in farm plantings. Finally, adapted seed from natural or planted stands has been hard to obtain in quantities large enough to handle economically.

Nevertheless, the advantages far outweigh the disadvantages. Furthermore, some of the obstacles can be overcome. In the drier portions of the Plains the use of potted trees and more careful handling of bare-rooted stock from the time of lifting in the nursery to planting have resulted in higher initial survivals. Improved machines and methods of tillage have increased both initial survival and growth rates. Increased use of trees grown from seed of established plantings and of native stands of proven hardiness should also provide trees that survive better and grow faster.

COLLECTION AND HANDLING OF SEED

IMPORTANCE OF SEED SOURCE

There is abundant evidence that conifer seed from local sources produces planting stock more resistant than imported stock to loss from drought, insects, and disease. Foresters and others engaged in tree planting in the Prairie-Plains generally agree on the importance of using seed sources adapted to local climate and soil conditions. However, this requisite too often is slighted or ignored. Since the advent of large-scale tree planting on the Plains, a large number of trees of unsuitable origin have failed or have grown poorly. Thus, much of the effort spent in seed collection, production of nursery stock, and establishment in the field has been wasted.

Though seed source research has been less extensive in the Prairie-Plains than in many other areas, there are some specific examples of seed source variation for conifer species grown in the Plains. In a study of the survival and growth of 25- to 41-year-old trees of six Scotch pine races under prairie conditions in Saskatchewan, differences were apparent and seemingly distinctly inherent (Cram and Brack 1953). Investigators have reported that the growth and survival of ponderosa pine is influenced by racial origin; they found wide variations in height growth and survival between lots of wide geographic origin and altitudinal zones (Bates 1927, Callaham and Metcalf 1959, Munger 1941, Weidman 1939). In the sandhills of Nebraska, planted ponderosa pine of Nebraska origin were less damaged by tip moth than were the trees of New Mexico seed source (Bates 1927). There was also variation among lots in browsing by deer.

The variability in hardiness of ponderosa pine grown from seed originating in different climates was evident in 6-year-old plantings in McHenry County, N. Dak. In March 1946, severe winter injury appeared as the pine underwent browning and defoliation. The heaviest damage was sustained by trees with Black Hills and western Nebraska origins, and the least by trees grown from seed of the nearest native origins (western North Dakota and eastern Montana). Again, following the winter of 1947–48, the trees of the near-local sources showed less foliage injury (Stoeckeler and Rudolf 1949).

Outstanding performances of the local sources have been observed many times at the Bessey Nursery, Halsey, Nebr. Scotch pine from a local collection produced 2–0 seedlings nearly twice as large as those from a central European source. Austrian pine from seed collected near Lincoln, Nebr., produced stock far more satisfactory than any Austrian pine previously grown. In 1955, it was noted that 2–0 ponderosa pine beds varied considerably by seed origin; the best lot was from a local collection.

The Nebraska National Forest, with 30,000 acres of conifer plantings established from 1903 to 1958, is an outstanding example of a site on which seed of local origin was used. The first trees planted were wildlings shipped in from the Black Hills and the Lake States, but the establishment of a nursery in 1902 soon made it possible to control the source of stock. In the spring of 1904, 1–0 ponderosa pine, grown from seed collected in 1902 in northwestern Nebraska, was planted. The first eastern redcedar seed used was collected in 1912 in a natural stand along the Niobrara River. In the early 1920's, seed of Austrian and Scotch pine was collected from ornamental and shelterbelt trees in eastern Nebraska to supplement seed purchased from Europe. These local plantings have demonstrated reasonably good adaptation to local conditions.

European countries have much broader experience

than the United States in the harmful effects of indiscriminate use of seed without regard to origin. Some of them have passed strict laws providing for the certification of the source of seed. There are no Federal or State laws in the Plains States requiring the use of forest tree and shrub seeds of known origins. However, certification of tree seed is now possible in South Dakota under State laws pertaining to cereal, forage, and oil crops. The International Crop Improvement Association approved minimum standards for tree seeds in 1959 and adopted more widely applicable standards in 1962 (SAF Seed Certification Subcommittee 1963).

In 1939 the U.S. Department of Agriculture adopted a seed policy that partly requires and partly recommends use of local or well-adapted seed for forestry and related purposes. It requires tree planting agencies in the Department to use in their planting programs, wherever practicable, seed of known origin from within 100 miles distance and 1,000 feet elevation of the planting site. It recommends keeping an accurate record of such seed, including the lot number, year of seed crop, species, origin as to State, county, and specific locality, range of elevation, and proof of origin. (See Appendix for entire policy statement.)

A suggested minimum program for collecting seed in the Prairie-Plains included the following points (Engstrom and Stoeckeler 1941):

1. Zone the seed collection area according to climate.
2. Limit collection largely to local seed.
3. Pick seed only from healthy and vigorous trees of reasonably good form.
4. Keep an accurate, permanent record of seed source from time of collection through field planting, including proper identification and labeling of the seed and the place and elevation of collection.
5. Import seed only after giving thorough study to the experience with seed from different foreign countries.

SEED COLLECTION ZONES AND LOCALITIES

Eleven seed collection zones, based primarily on latitude, have been delineated for the Prairie-Plains (fig. 5). It is recommended that seed be collected and the progeny planted within the same zone. Where absolutely necessary it is permissible to move seed or stock from one zone to an adjoining zone. Compensating factors such as elevation would permit movement of seed northward across one or two States. Thus, blue spruce seed can be moved safely from the higher western part of the more southern seed zones in Colorado and Wyoming to northern North Dakota (Engstrom and Stoeckeler 1941). A little movement to the north may result in reasonably hardy trees that grow slightly faster than trees of local origin. These zones were based on observation and experience and proved workable in the Prairie States Forestry Project. It is recommended that they be used until research discloses a better basis for zonation.

Trees from northern seed planted farther south generally survive fairly well; however, they may grow slowly, develop poorly, and eventually succumb to drought and heat. If the northern stock buds out on the first warm days of spring, the new growth may be damaged by frost. When trees grown from southern seed are used too far north, they may soon die because they lack the hardiness and early ripening of wood necessary to withstand the northern winters (Engstrom and Stoeckeler 1941).

Movements from east to west—that is, generally to drier climates—appear less harmful than latitudinal movements but should not be encouraged (Engstrom and Stoeckeler 1941).

Although the seed collection zones shown in figure 5 are generally applicable to most conifer species in the Prairie-Plains, more specific localities can be given for collecting seed of a few species in certain areas. Ponderosa pine seed should be collected from the more arid portions of its range bordering the Plains. Good

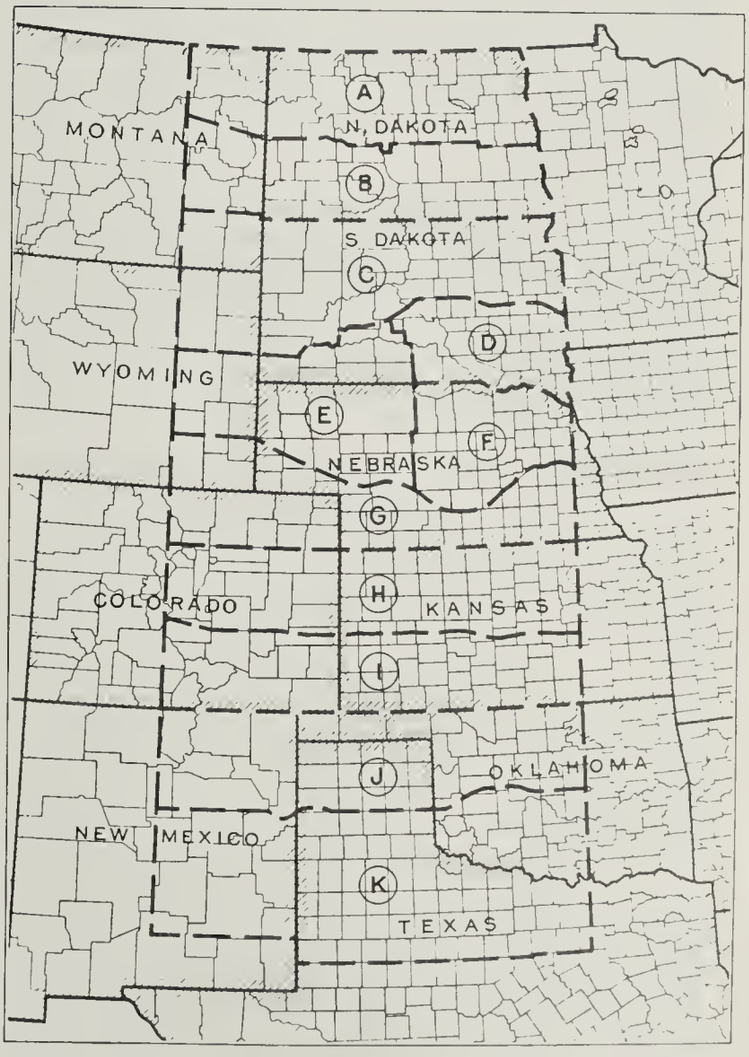

FIGURE 5.—Seed collection zone map for the Prairie-Plains. Broken lines separate the zones (Engstrom and Stoeckeler 1941).

sources in Nebraska are the Pine Ridge and Niobrara River areas; in South Dakota, the northwest and on the Rosebud and Pine Ridge Indian Reservations in the southwest; in North Dakota, the southwest; and in Montana, the extreme east. Seed from the foothills of the Black Hills has been used rather extensively because the quantity of seed produced is greater and more reliable than in other collection areas. Further study will be needed before this source can be fully evaluated, but it seems likely that at least some Black Hills seed can be used with confidence in Nebraska and to the north. Eastern Colorado sources seem best for use in Kansas and to the south.

Seed collections of Rocky Mountain juniper and eastern redcedar should be made as near the latitude of the planting site as practicable.

Rocky Mountain juniper should be collected in North Dakota along the Little Missouri River near Medora, in northwestern South Dakota, and in extreme eastern Montana.

Seed of eastern redcedar should be collected in South Dakota from the bluffs of the Cheyenne River and from other native stands. However, seed collected along the Platte River in Nebraska does reasonably well in South Dakota (Hansen 1930). In Nebraska, eastern redcedar sources in and adjacent to Custer, Loup, Blaine, and Brown Counties have produced stock better suited to statewide planting than seedlings of Platte Valley origin. Collections of redcedar along the Cimarron River have proved well adapted to Oklahoma planting sites.

In the prairie provinces of Canada, spruce seed collected from older specimens in windbreaks of the nurseries at Indian Head and Sutherland and from natural stands in Manitoba and northern Saskatchewan have produced stock adapted to Canadian conditions (Ross 1937). Generally, common commercial seed has not proved hardy.

SELECTION OF INDIVIDUAL STANDS AND TREES

Next in importance to using seed from local sources is collection from selected stands and individual trees with desirable characteristics. Tree improvement studies of forest trees have revealed wide variations between individuals of the same species (fig. 6). Superior trees with desirable characteristics should be noted, and their location should be recorded.

Some traits of value in windbreak and shelterbelt trees are tolerance of drought conditions, ability to grow on alkaline soils, and resistance to snow, wind, and glaze injury (Rudolf 1956). Other desirable characteristics are compactness, resistance to insects and disease, and rapid growth without spindliness.

Trees and stands that are superior in growth characteristics should be used for seed collection as much as possible. Cones obtained from squirrel caches may be of good genetic character only if the stand as a whole is composed of trees of good form.

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FIGURE 6.—A row of 21-year-old ponderosa pine in the North Dakota State Nursery at Towner, McHenry County, N. Dak. The differences in height growth, broadness of crown, density of foliage, and angle of branching illustrate the wide variation between individuals of the same seed source.

If block plantings are being considered for wood production, the form and height of the parent tree and quality of the product must also be considered. Lumber from ponderosa pine growing on the hills along the Little Missouri River northwest of Amidon, N. Dak., reportedly was brash and inferior to lumber cut from trees about 35 miles distant in the Long Pines or Ekalaka Divisions of the Custer National Forest in Montana. Of course, it is not known whether these differences stem chiefly from genetic or acquired characteristics.

Seed orchards should also be established from the material of carefully selected stands. Seed orchards of hardy and desirable form of oriental arborvitae and Arizona cypress have been established in Oklahoma.[2] Similar developments are likely to be planted in other Prairie-Plains States.

DETERMINATION OF SEED RIPENESS AND QUALITY

The soundness of seeds by locality or even by plant should be tested before extensive collecting is done. Seed viability may vary considerably among stands and trees. Seeds from each tree can be tested quickly by cutting them open with a small wire nipper and seeing whether they are filled. This practice, carefully followed, will eliminate trees with many weeviled and hollow seeds before considerable labor and money are expended.

[2] Personal communication with E. W. Johnson, Agricultural Research Service Field Station, Woodward, Okla.

The ripeness of seed must also be judged during collection, since immature seed does not keep as well as ripe seed in storage and is of lower germination capacity (Engstrom and Stoeckeler 1941). Seedlings from immature seeds are smaller and less vigorous than those from mature seeds (Toumey and Korstian 1942). Cutting tests are also recommended to estimate seed maturity. The kernel of a mature seed is firm and white or cream colored, and fills the cavity completely.

Ripening dates of a species vary by season or locality because of local climate. Therefore, frequent inspections may be required to determine in advance the approximate ripening dates. Failure to closely observe the progress of ripening for species that hold their seed for only a few days after maturity, such as limber pine and oriental arborvitae, may result in loss of the crop.

The seed of Rocky Mountain juniper takes 2 years to mature. One-year fruit is light green as compared to the light blue of the mature fruit. It should not be collected since the green and mature berries are hard to separate. No collections should be made from trees with large amounts of green berries.

In Nebraska, under dry conditions, ponderosa pine cones can usually be collected directly from the trees only during the 2 to 3 weeks between the time proper ripeness is reached and the opening of cones on the trees. The seed of Austrian pine ripens 2 weeks later than that of ponderosa pine; the cones remain closed longer, sometimes through the winter.[3]

Ponderosa pine cones are ripe enough to collect when their specific gravity in place on the tree has dropped to 0.85, or when a majority of five sound, freshly picked cones will float in kerosene. The time of squirrel collection is not a reliable index of seed ripeness since they often cut the cones 3 to 4 weeks in advance of seed maturity. Color also is not a reliable index of cone ripeness (Maki 1940).

Spruce cones are ripe enough to collect when the seed coats darken and the kernels become firm (U.S. Forest Serv. 1948). In a study of seed maturity of planted spruce in Saskatchewan, it was recommended that collection of blue spruce cones be delayed until 90 percent or more freshly picked cones float in linseed oil, which has a specific gravity of 0.94 (Cram 1956a). For white spruce, collection is recommended when 90 percent or more freshly picked cones float in turpentine (Cram 1957).

The berries of eastern redcedar, Rocky Mountain juniper, and oldfield common juniper are dark blue when ripe. However, they are usually coated with a powdery bloom; therefore, they appear light blue.

For a further discussion on the seed ripening process and the time to collect, refer to the "Woody-Plant Seed Manual" (U.S. Forest Serv. 1948).

[3] Personal communication with M. K. Meines, Superintendent, Bessey Nursery, Halsey, Nebr.

SEED CROP FREQUENCY

The size of seed crops will vary from year to year, depending on several factors. Among the most important are the climatic conditions during flowering, seed formation, and ripening; the damaging effect of insects and rodents; the age of the seed trees; the size of the flower crops; and the inherent ability of the tree or species to produce seed. Seed may be destroyed by insects that attack the buds, flowers, and immature cones, as well as the seed itself (Lanquist 1946). Seed production by eastern redcedar is often reduced by late spring frosts which damage the female flowers.

No periodicity in seed crops has been noted in ponderosa pine (Curtis and Lynch 1957). Observations over 23 years east of the Continental Divide in Montana showed this species to be a poor seeder—only one good seed crop occurred (Boe 1954). Two good crops, two fair ones, and five failures were recorded during a 9-year period in the foothills of the Rockies in eastern Colorado (Roeser 1941).

Junipers produce more good seed crops. Particularly heavy crops of Rocky Mountain juniper seed are produced every 2 to 5 years, and some seed is borne nearly every year (Sudworth 1915). Eastern redcedar produces good crops every 2 to 3 years in Oklahoma (Afanasiev and Cress 1942a). The same frequency of good seed years occurs at Halsey, Nebr., where nine good seed crops of eastern redcedar were recorded in windbreak plantings between 1929 and 1956. Seed production of trees in windbreak plantings may differ from that of trees in wild stands because of dissimilar growing conditions and parentage.

Availability of seed in the quantities necessary to fill nursery seeding and planting quotas must also be considered along with the climatic adaptability of any source or "strain." Some species set a good crop of cones at infrequent intervals. Usually some seed is produced in other years, but it is generally scattered and is often so poor that the cost of a pound averaging 50 percent or more in germination may be three or four times as high as seed collected in a good seed year.

Since most seed retains its viability well when stored properly, it is good to provide for the future in years when a good supply of high-quality seed is obtainable.

SEED YIELDS

Complete records on seed yields of species commonly used in Prairie-Plains tree planting are available in the "Woody-Plant Seed Manual" (U.S. Forest Serv. 1948). However, localized information on yields is desirable since some widely used species have extensive ranges outside the Plains.

Data on the seed yield of ponderosa pine, eastern redcedar, and Rocky Mountain juniper in native stands of the Great Plains were obtained primarily from the Bessey Nursery records, which cover a period of more than 50 years (tables 1 and 2). Collections were made in most years. The range in yields is perhaps wider than would normally be expected, and resulted indirectly from the policy of the Nebraska

TABLE 1.—*Ponderosa pine: yield of freshly collected, cleaned seed in native stands of the Great Plains*

Locality	Collections	Yield per bushel of cones		Seed per pound		
		Average	Range	Low	High	Average
	Number	*Ounces*	*Ounces*	*Number*	*Number*	*Number*
Nebraska [1]	7	20	13–36	8, 200	11, 500	9, 700
Black Hills	3	20	18–22	13, 400	16, 600	14, 600
Eastern Montana [2]	6	([3])	([3])	12, 600	19, 300	15, 700

[1] Seed from stands along the Niobrara River at Pine Canyon in Custer County and from one collection on the Rosebud Indian Reservation in South Dakota.

[2] From collections at Fallon, Glendive, and Jordan, Mont.

[3] Data not available.

National Forest of collecting as much seed locally as was possible. Also, the berries or cones occasionally yielded little viable seed, owing to insect infestations or other causes.

The yield of ponderosa pine varies from 13 to 36 ounces per bushel for Nebraska cones, and from 18 to 22 ounces for cones from the Black Hills (table 1). Average yields, 20 ounces per bushel of cones, are about the same for the two sources.

The low yields of eastern redcedar in Nebraska represent collections in years when the seed crop was poor and insect infested (table 2). The larger yields are for good to excellent seed years.

Now that many planted stands are bearing seed, the nurseryman has a much wider selection of parent trees from which to collect. Seed collection from mature stands or from those of known seed origin is preferable.

Redcedar berries have been collected for many years from a windbreak 60 years old at Anselmo, Nebr. The trees are probably of natural origin and have produced as much as 80 pounds of berries per tree. At Anselmo an experienced man can pick an average of 40 pounds of berries per day in years of good to excellent crops.

Few records are available for seed production in planted stands of conifers in the Plains, but there is a partial record for such stands on the Nebraska National Forest (table 3).

This record indicated that planted stands will yield good seed in economical quantities whether they be in block plantings or in individual rows of shelterbelts. The yield of ponderosa pine seed in plantations at Halsey, Nebr., an average of 20 ounces per bushel of cones, compared very well with that of native stands. Austrian, Scotch, and jack pine from local sources provided a supply of good-quality seed from acclimated trees. The seed tended to be larger than that obtained from the native sources of the three species. Some seed was produced on Scotch and jack pine trees less than 20 years old, but substantial quantities were not produced from Scotch, Austrian, and ponderosa pine until they were 25 to 30 years old. In Oklahoma, Johnson [4] noted that Austrian pine does not produce much seed before the trees are 20 years old.

The number of seed per pound also varies consid-

[4] Personal communication with E. W. Johnson, Agricultural Research Service Field Station, Woodward, Okla.

TABLE 2.—*Juniperus: yield of newly collected, cleaned seed in natural and planted stands*

Species and locality	Collections	Yield per 100 pounds of berries		Seed per pound		
		Average	Range	Low	High	Average
Eastern redcedar:	*Number*	*Pounds*	*Pounds*	*Number*	*Number*	*Number*
Nebraska, planted [1]	20	15. 3	4–20	37, 200	55, 000	43, 200
Nebraska, natural stands [2]	9	16. 2	3–18	37, 000	53, 300	42, 800
South Dakota, natural stands	3	17. 5	14–19	42, 200	46, 100	43, 400
Oklahoma, natural stands	([3])	14. 0	7–16	([3])	([3])	([3])
Rocky Mountain juniper:						
South Dakota, Nebraska, Wyoming, and Montana natural stands. [4]	12	19. 8	11–28	22, 000	32, 000	27, 200

[1] Planted windbreaks at Anselmo and Halsey. Yields based on 27,000 pounds of berries.

[2] Yields based on 9,439 pounds of berries.

[3] Data not available.

[4] Yields based on 3,637 pounds of berries.

TABLE 3.—*Pinus: yield of newly collected, cleaned seed in planted stands, Nebraska National Forest*

Species	Collections	Yield per bushel of cones	Seed per pound		
			Low	High	Average
	Number	*Ounces*	*Number*	*Number*	*Number*
Ponderosa pine	2	23–24	10, 200	12, 200	11, 200
Austrian pine [1]	8	6–15	14, 000	22, 800	18, 500
Scotch pine	3	6–12	42, 200	57, 100	48, 100
Jack pine	5	6–13	74, 100	85, 300	79, 100

[1] Seed from stands near Lincoln, York, and Oakland, Nebr., averaged 20,300 per pound.

erably, depending on the locality of the collection, season, and degree of dryness. Fresh seed tends to be heavier than seed that has been stored over a period of years, so averages are given for newly collected seed.

Conifers are sometimes depredated by cone- and seed-eating insects. The cone moth *Dioryctria auranticella* (Grote) was noted at Halsey in 1928, about the time when ponderosa pines were first starting to bear cones. This insect is common in native ponderosa pine stands in adjacent areas of Nebraska and South Dakota. Blue spruce cones have been damaged in southern Saskatchewan by the spruce coneworm (*D. reniculella*) (Grote) and those of white spruce by the spruce seedmoth *Laspeyresia youngana* (Kft.) (Peterson and Worden 1959). Other insect enemies undoubtedly are also present.

METHODS OF SEED COLLECTION

Seed collection in the Plains often involves much travel over widely scattered areas and use of special collecting equipment. The equipment necessary for efficient seed collection varies by species. However, nursery labor and equipment can be used to make local seed collections of some species. For a season's work on various species, collection crews should be equipped with wire nippers or side cutters for field cutting tests and other purposes, cutting hooks for detaching cones (fig. 7), ladders, picking bags, baskets, sacks, tags, twine, ropes, linemen's safety belts, goggles, hardhats, heavy leather gloves, and tarpaulins or seed sheets.

A nursery practice handbook, based on many years of experience at the Bessey Nursey, contains the following suggestions for seed collection in planted and natural stands of conifers.

Purchased seed should be obtained from a reliable collector or seed dealer who will guarantee the collection area and year of collection (see "Where to Purchase Seed," in appendix).

The foremen define the seed collecting areas and select individual trees desirable as to age, tree form, and other characteristics. Pickers work in pairs to facilitate the movement of the ladders and other equipment from tree to tree. Man-day production is greater when trees of low yield are bypassed. Collection methods to be used depend on the characteristics of each species.

Because they are borne mostly on the branch tips, ponderosa pine cones can be picked more efficiently from ladders than by climbing the trees. For safety, pickers should carry a short rope on the top rung of

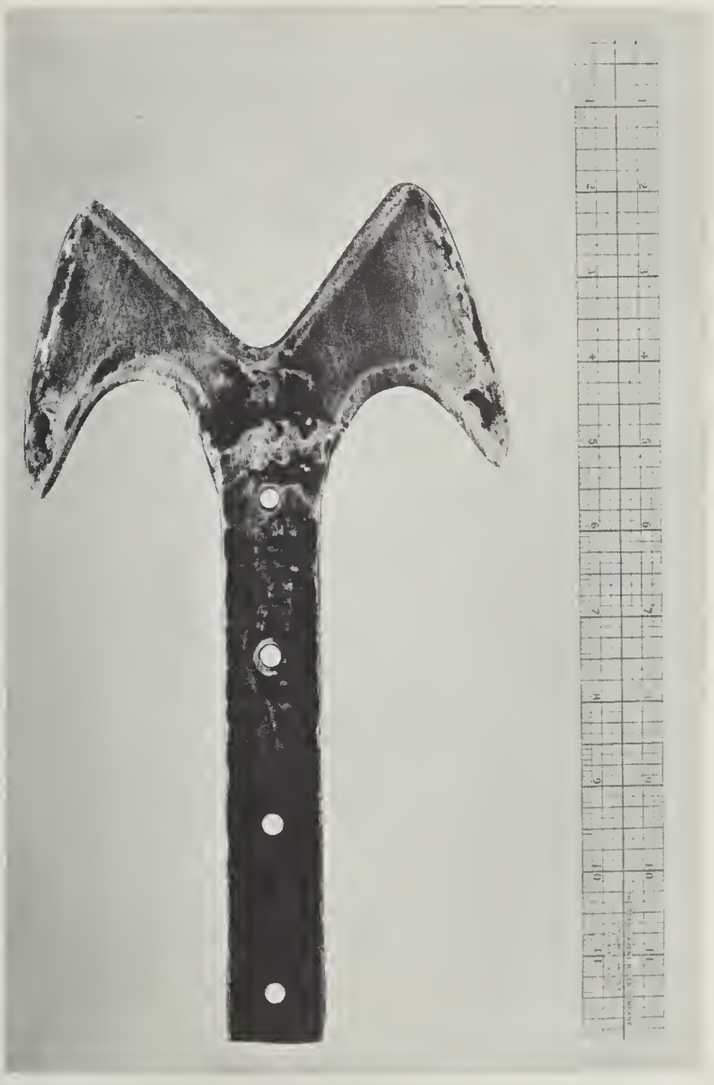

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FIGURE 7.—A cutting hook for detaching fruit, cones, or small limbs from trees; it is made from two mower blades welded to a flat piece of steel 8½ inches long.

the ladder and tie the ladder to a stout branch or to the tree bole. Cone hooks are used to bring cone-laden branches toward the picker and to cut loose cones beyond arm reach. The cones usually are dropped and picked up later. In the well-stocked stands of the Black Hills, ponderosa pine cone collections can be made from squirrel hoards.

Austrian pines are easier to climb than ponderosa pines, and the cones come off easier. Serotinous jack pine cones have been collected from branches removed during pruning and thinning. Limber pine tends to open its cones rapidly, and the wingless seed may fall to the ground. However, the seed will remain in the open cone on the tree for a few days if there is no wind, and much of it can be saved by spreading tarpaulins under the tree before the cones are picked. When the picker is working on the ground or on low ladders, the cones are put in a sack worn around the neck.

Juniper berries are collected on the Nebraska Forest by stripping them directly into picking bags or baskets strapped to pickers, by rubbing or stripping them into tarpaulins spread under the trees (fig. 8), or by a combination of these methods. The branch is taken between the hands, and near its end it is rubbed with a rolling motion. Part of the debris can be removed while the fruit is still on the tarpaulins by shaking them to bring the coarse material to the surface.

An alternate method, one of those used in cold weather, is to beat the frozen berries from the branches with a stick 12 to 18 inches long and 1 to 2 inches thick. The end of the stick is padded with several layers of burlap.

Quite often more than half the tree seed can be reached from the ground, and the rest can be gathered from short ladders. If the crop is good, the tree need not be picked clean. When good seed trees are few, the older and taller trees may furnish most of the good seed, and taller ladders are needed.

Tarpaulins are not used in brushy areas or on steep slopes. Here, bags with open-hooped mouths are hung from the neck. The use of strippers mounted on poles has damaged trees and resulted in an accumulation of much trash among the seed.

F–334697

FIGURE 8.—Collecting eastern redcedar berries from native trees in the Platte River Valley near Fremont, Nebr.

The seed of oriental arborvitae and some Arizona cypress is obtained from planted trees. The seed of oriental arborvitae must be picked promptly when the cones begin to open and before the small seed falls to the ground. The cones of Arizona cypress remain closed on the tree, permitting a longer period for collection.

CARE OF FRESH SEED

Seeds of most conifers are not dry enough to be stored immediately after collection. They must receive adequate aeration or be placed in a dry atmosphere. If the seed cannot be extracted immediately, the freshly gathered fruits should be spread in a thin layer in a dry place in the open and stirred occasionally for several days following collection. Freshly picked pine cones and juniper berries heat rapidly if left in sacks or deep piles. Therefore, layers of fruit should not be more than 2 to 4 inches thick. After drying, the fruits can be stored temporarily in bags while awaiting extraction.

Where cone storage sheds are available, the cones can be stored in trays for drying prior to extraction of the seed (fig. 9).

SEED EXTRACTION AND CLEANING

A modern seed extractory is desirable if the size of the nursery and its production schedule require large quantities of pine or spruce seeds. Less elaborate facilities suffice when smaller quantities of cones are to be handled. At Norman, Okla., up to 60 bushels of loblolly and shortleaf pine cones can be handled per day in a 25- by 25-foot cone-drying room. This drying unit is heated by gas (a 112,000 B.t.u. heater). Cone trays with a screen-wire bottom are made from 2 by 4's.

F-488915

FIGURE 9.—A cone storage shed at Big Sioux Conifer Nursery, Watertown, S. Dak. The cone storage portion of the building on the right is connected directly to the extractory.

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FIGURE 10.—Ponderosa pine cones placed on racks for extraction. Tarpaulins are used to prevent the loss of seed as the cones open. Bessey Nursery, Halsey, Nebr.

Although artificial heating results in greater extraction of the seed, solar heat and air drying often are satisfactory. The cones are placed out of doors in the sun on screens or tarpaulins (fig. 10). When open, they are shoveled into a screened tumbler; the seeds fall to the floor from one end of the tumbler, and the empty cones discharge from the other end. Further recovery of seed remaining in the cones can be secured by threshing them in an improvised combine or low revolution-per-minute hammermill. The efficiency of the solar extraction can be raised materially by allowing the cones to remain on the trees almost to the time of natural seed fall.

Fresh cones that have been predried in the sun will open readily; cones that have been stored may not. Maki (1940) found that cones fail to open satisfactorily when they have been dried out gradually in cool, dark places or have been stored in sacks and other containers where the scales could not open. Cones that have been stored long enough to become dry without opening may have to be moistened before they will open satisfactorily.

Dewinging of ponderosa pine seed is simplified by wetting. The seed is sacked and dipped in water long enough to swell the wing collars, or loose seed is spread in layers one-half to 1 inch deep and moistened. The seed is then placed on screens to dry with occasional stirring. When sufficiently dried, the wings are loose and can be fanned out.

Small quantities of dry seed can be dewinged by rubbing them in a cloth sack and then winnowing. For large quantities, some type of mechanical dewinger is needed. Lanquist (1954b) cleaned and dewinged seed in a machine adapted from a dustless hammermill that was designed by the Soil Conservation Service (Steavenson 1940). The hammers of the mill are

replaced by a brush arrangement for dewinging the seed. The screen size depends on the seed size. With a brush speed of 184 r.p.m., almost all of the wings are removed in one operation. The mechanical dewingers must be used carefully to avoid injury to the seed (U.S. Forest Serv. 1948).

Seed extraction for the juniper species is mostly a process of running the berries through a fanning mill to remove foliage and other trash, macerating the berries, and removing the pulp residue by flotation and screening. Numerous types of macerators have been successfully employed.

A macerator developed by the Forest Service is often used (fig. 11). It is of all-metal construction and is built on the principle of a threshing machine with cylinder and concaves. The capacity of the macerator is governed by the length of the cylinder, which varies from 12 to 18 inches. The machine may have fixed plates, but adjustable macerating plates are available so that different clearance widths can be obtained for the various types of seeds processed. A good power unit for operating this machine is a 1-hp. electric motor or a small gasoline engine. Commercial models which operate similarly are also available.

The machine is run at a rather high speed, with the discharge slide wide open to thresh the fruit from the leaves and twigs. The seed is separated from the pulp by closing the discharge opening and decreasing the speed. This machine, equipped with a 12-inch cylinder with teeth spaced to provide three-eighth-inch clearances, has handled 1,000 to 1,500 pounds of juniper berries per day (Engstrom and Stoeckeler 1941).

At the Bessey Nursery, a large meat grinder is now used. The grinder is electrically driven and operates in a normal manner, except that the cutting blade is reversed on the shaft to prevent injury to the seed as the berries are forced through the disk sieve. The berries can be run through the grinder as fast as one man can fill the grinder and handle the pulp. For complete maceration, they are run through the grinder two or three times without water.

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FIGURE 11.—Macerating juniper berries in a specially constructed macerator. The machine can also be used to thresh the fruit, leaves, and twigs by operating it at a rather high speed, with the discharge slide wide open.

A hammermill was used extensively by the Soil Conservation Service nurseries to extract juniper seed. The mill was run at a speed of about 400 r.p.m. by a farm tractor with a flat-belt drive. The fruit was poured into the mill, and ample quantities of water were supplied by one or two garden hoses (Steavenson 1940). After 14 to 20 minutes of treatment, the clean seed had collected on a screen in the bottom of the mill. This material was then dumped on screens to dry. Finally, it was run through the fanning mill to separate the seeds from the debris.

After most maceration processes, the seed usually needs further cleaning. First the mixture of seed and pulp is soaked for 1 or 2 days in a lye solution (1 teaspoon of lye to 1 gallon of water). This separates the seed from the remaining pulp, which is very oily and resinous, and which would hinder seed washing and flotation and subsequent seed stratification. After the lye treatment, the mass is dumped into screened trays and thoroughly washed by forcing water through it under pressure to remove the lye and most of the remaining pulp; only the berry hulls and seed are left.

The sound seed can usually be separated from the berry hulls and from floaters (empty or light seed) by flotation (Engstrom and Stoeckeler 1941). This method is based on variation in buoyancy under agitation in water. Some of the macerated material is placed in a slightly tilted large washtub into which a stream of water from a garden hose is directed at such an angle as to create a rotary swirl and a lifting effect on the material. Slight stirring of the material in the bottom of the tub is also necessary. The pulp and light seed will float to the surface and spill over the edge of the tub as the water overflows. The seed is then dried on tarpaulins in the sun or on trays in the extracting room. Finally it is fanned to remove the remaining empties and small seeds.

After extraction, the moisture content of seeds should be determined, particularly that of conifer seeds scheduled for several years' storage. The preferred moisture content of seeds used in Prairie-Plains nurseries is detailed in the following section on seed storage.

Kiln-dried or air-dried seed from dry climates often need no additional drying. Wahlenberg (1925) recommended that, when possible, ponderosa pine seed should be dried at ordinary temperatures instead of in a kiln. A seed drier may be used to dry seed following extraction, especially during winter when air drying outdoors is not feasible and inside drying space is limited. A rotary drier, consisting of a screen-wire cylinder 32 inches long and 32 inches in diameter with wooden ends of one-half inch lumber, has been used by the Forest Service (Engstrom and Stoeckeler 1941). The three 1- by 3-inch baffleboards, equally spaced within the periphery of the cylinder, pick up the seed as

the drum revolves and slowly spill it in a thin stream as each baffle reaches the highest point. Warm air from the heater, forced through a revolving cylinder by an electric fan, hastens the evaporation of moisture from the seed. The optimum speed for the cylinder is 12 to 15 r.p.m. There is danger, however, of too rapid or excessive drying.

SEED STORAGE

Because of the irregularity of conifer seed crops, it is essential that stocks of seed be kept for several years. Lack of knowledge on proper storage conditions resulted in heavy losses during early reforestation efforts. Therefore, extensive research has been done on seed storage.

One of the two critical factors is moisture content of the seed. Satisfactory ranges or levels of moisture content prior to storage have been determined to be as follows: Pine species other than southern pine, 5 to 8 percent; spruce including white and Engelmann, 8 percent (Holmes and Buszewicz 1958); loblolly and shortleaf pine, 9 to 12 percent (Wakeley 1954); and eastern redcedar, 7 percent (U.S. Forest Serv. 1948).

To maintain these moisture contents it is usually more practical to use sealed containers than to have the whole storage chamber kept at a low humidity. A common type of seed container is a cylindrical can about 36 inches tall and 18 inches in diameter fitted with a bronze screwcap and sealed with a rubber gasket. Such cans have an approximate capacity of 150 to 160 pounds of conifer seed. Cardboard containers of various sizes are used at the Towner Nursery. The seed is put in a polyethylene bag and placed in the container. A press-on lid is held in place by wire clamps. At the Oklahoma State Nursery at Norman, 5-gallon glass bottles with screwcaps are used. Each bottle holds 25 pounds of seed. Small lots of seed can be kept in jars or similar containers sealed with paraffin.

Low temperature is the other essential condition for successful storage. Dry cold storage at 32° to 40° F. in sealed containers is satisfactory for prolonged storage of seeds of all pines, spruces, junipers, Arizona cypress, oriental arborvitae, and larches (U.S. Forest Serv. 1948). Seed apparently can withstand subfreezing temperatures for several years without injury if it is stored in sealed containers and has a moisture content of less than 7 percent. Hence, most commercial cold-storage facilities can be used to store seed (Rudolf 1952). Seed of ponderosa, loblolly, and shortleaf pines and of white spruce kept well for 4 to 7 years at subfreezing temperatures (Barton 1935).

In some of the larger Plains conifer nurseries, seed is stored in specially constructed seed-storage facilities. At the Towner Nursery, a 10- by 10-foot walk-in cooler is used. Other nurseries store seed in refrigerated planting-stock storage warehouses. At the Bessey Nursery, several large refrigeration units are used.

A few examples will illustrate the effectiveness of dry cold storage and the magnitude of seed loss that may occur where improper methods are used.

Ponderosa pine seed sealed in airtight containers and held at 41° F. for 10 years maintained their viability. One seed lot stored for 17 years and the other for 18 years had a viability of 75 to 94 percent (Schubert 1954). Under similar storage conditions, Arizona cypress seed retained viability for 11 to 20 years.

Oriental arborvitae seed has retained viability (95 percent) for 18 years when stored in sealed containers and placed in refrigerators.[5]

Ponderosa pine seed with a moisture content of 15 percent when stored maintained their germination after 3 years' storage in canvas bags at −4° C. (Barton 1954). Germination was reduced 20 percent during the same period when seed with a moisture content of 17 percent was stored at −11°.

Germination of Austrian pine seed with a moisture content of about 8.5 percent, stored for 4 years in sealed containers at 2° C., was 63 percent, compared with an initial germination of 72 percent. Seed from the same lot stored in a sack in an unheated room showed only 1-percent germination.

The seed of white spruce with a moisture content of 6.7 percent showed an insignificant loss in germination after 7 years' storage in sealed containers at 0° and −18° C. When stored in sealed containers at room temperatures, none of the seed germinated (Allen 1957).

Juniperus seed can survive even longer periods of storage when stored dry in sealed containers at low temperatures. The seed of Rocky Mountain juniper stored in a cool cellar (50° to 65° F.) showed about 30 percent germination after 3½ years (U.S. Forest Serv. 1948). Johnsen (1959) found that seed of three western species could survive long periods of dry storage in bags or jars. The germination of 45-year-old Utah juniper seed was 17 percent; 21-year-old one-seed juniper, 54 percent; and 9-year-old alligator juniper, 16 percent.

SEED TESTING

Accurate tests of the number of seeds per pound, purity, and germination percent are necessary if seed is to be sown in the nursery at rates that will assure approximately the desired stand per square foot. Thin stands waste space, allow weed growth, and increase planting stock costs. Overdense seedbeds produce undersized, spindly stock with a high cull percent and poor survival or growth. The procedures used in seed testing are thoroughly discussed in the "Woody-Plant Seed Manual" (U.S. Forest Serv. 1948). New tree seed testing recommendations of the Association of Official Seed Analysts are expected to be available in 1965.

Care must be taken to obtain a representative sample

[5] Communication with Michel Afanasiev, Forestry Dept., Oklahoma A. & M. College, Stillwater, Okla., April 1958.

of seed. With a conventional grain probe, a uniform, equal sample may be taken from the top to the bottom of the container. Where seed lots of the same year and origin are stored in more than one container, samples from each container are taken and mixed. This sample must then be subdivided until a small representative sample of 2,000 to 3,000 seeds is obtained. A sample can be subdivided by mixing, quartering, and again mixing, or by using a mechanical device.

Perhaps the most reliable tests of seed viability are those in which the seed is allowed to germinate naturally under ideal conditions of moisture and temperature. Usually 30 to 60 days are required, so tests are run before the spring sowing season.

In many Plains nurseries, 200 to 250 seeds of any one lot are sown in flats that are filled with washed and sterilized fine sand (fig. 12). The exact number of seeds is counted and broadcast uniformly over the sand or lined out in rows. The seed is pressed lightly into the surface, sand is sifted over it, and the surplus is struck off with a slat to obtain uniform depth. The flat is then labeled with the seed collection or accession number.

For species that germinate promptly without pretreatment, the flats are placed in a greenhouse or in a germination room that can be lighted during the normal daylight hours and heated to provide a diurnal fluctuation from 68° to 86° F. (Stoeckeler and Jones 1957). The flats are watered daily. Once germination starts, the seedlings are removed every 1 to 3 days and recorded. Ungerminated seeds remain in the flats until germination appears complete, usually in 30 to 60 days.

Germination can also be tested by placing the seeds between moist blotter paper in petri dishes. The blotters should be supported above the free water on the bottom of the petri dish, but should be connected to it by strips of blotting paper. The seed should be kept moist but not wet. Equipment should be sterilized with heat or boiling water to reduce mold.

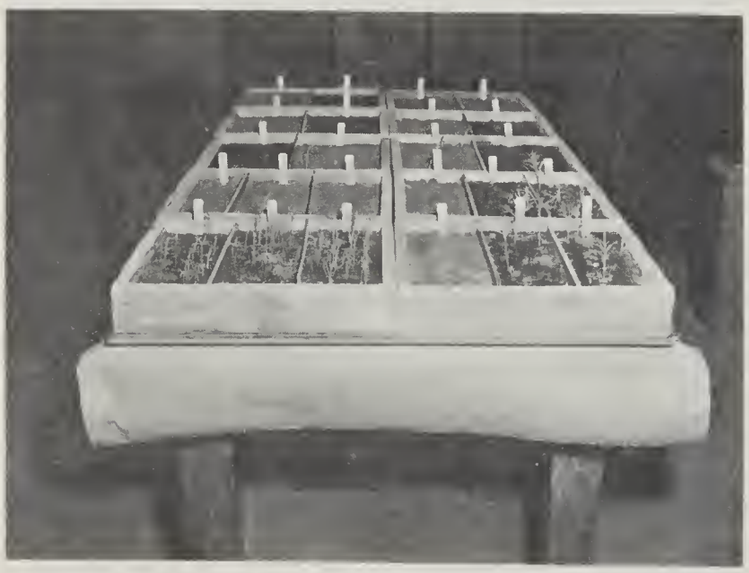

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FIGURE 12.—Ten- by fourteen-inch flats used at the Bessey Nursery, Halsey, Nebr., in germination tests of coniferous seed. A mixture of half sand and half peat is being used as a medium.

A Jacobson germinator [6] or similar device can be used in lieu of petri dish tests (U.S. Forest Serv. 1948). A number of constant-temperature germinators are available. These devices greatly speed the process of determining potential germination.

Cutting tests are commonly used by nurserymen for a rough determination of seed quality. They are useful as emergency guides in fall sowing of freshly collected seed that have embryo dormancy, or for other seed that have not been tested. In cutting tests, several hundred seeds are cut open with a sharp knife, and the percentage of good seeds is determined. Good seeds are well filled and have white or cream-colored kernels.

Another rapid method of obtaining the germination value for dormant seed is the excised-embryo test. The embryos are dissected from the seeds, placed on moist, sterile cotton in petri dishes, and kept at about 70° F. for 2 to 31 days. During this period live embryos show various types and degrees of development, such as enlargement of the cotyledons, development of green color, and even emergence of radicle (Flemion 1941). Those that are not viable discolor and soon deteriorate. The excised-embryo test has worked successfully on *Juniperus* species, ponderosa pine, and Douglas-fir (Heit 1955). This test eliminates the effect of seedcoats and checks the condition of the embryo, where the life of the plant exists.

The most rapid viability indicator is a biochemical method that uses tetrazolium salts. The embryos are exposed and placed in a testing solution consisting of 0.5 gram of 2,3,5-triphenyl tetrazolium chloride in 200 cubic centimeters of water. The chemical stains living tissues a carmine red within 24 hours. Seed viability results obtained with a test using tetrazolium chloride compared closely with those from the excised-embryo test (On 1952). Both gave significantly higher germination capacities for ponderosa pine and Douglas-fir than those obtained by sand flats. The tetrazolium (TZ) test has many inherent advantages over other testing methods, but the accuracy of results depends on the qualifications of the analysts who interpret it (Colbry et al. 1961). It cannot be recommended for general usage.

Facilities for testing tree seed are not available at any of the Plains States seed-testing laboratories. However, tree seeds used in Plains nurseries can be tested for a fee at the Eastern Tree Seed Testing Laboratory, Macon, Ga., cooperatively maintained by the Georgia Forestry Commission and the U.S. Forest Service; the Oregon Seed Testing Laboratory at Corvallis; or the Department of Seed Investigations, New York State Agricultural Experiment Station, Geneva.

[6] Mention of commercial products or specific firms does not constitute an endorsement by the Forest Service or the U.S. Department of Agriculture.

The fees are prorated according to the total number of tests made during the season. They have averaged $10 to $12 per test. Tests are run for Federal, State, and private nurseries, and for commercial seed dealers.

SEED DORMANCY AND PRETREATMENT

Seed of some conifers, including ponderosa, Austrian, Scotch, and jack pine, germinate satisfactorily without pretreatment. Other seed, including that of some spruces, show embryo dormancy and germinate better if fall sown or stratified prior to spring sowing. Germination of some seed, such as eastern redcedar and Rocky Mountain juniper, may be delayed by the presence of an impermeable seedcoat in addition to embryo dormancy.

Usually dormancy can be overcome by a period of cold, moist stratification, during which certain chemical changes occur in the seed, preparing it for prompt germination. Pretreatment of seed frequently results in more rapid, even, complete germination. Seed is used more efficiently, and losses from disease are reduced. It is decidedly beneficial when seed that has been stored for some time is to be sown. However, stratification should not be regarded as an alternate means of seed storage since seed has been ruined by overlong stratification.

The seed of most pines used in Plains planting will germinate well without stratification. Ponderosa pine lots usually do not need stratification, but it will hasten and improve the germination of some lots. Mirov (1936) cites the need of pregerminative chilling in the presence of moisture; he obtained a 7-percent increase in germination from seeds stratified for 3 months at 40° F. Taylor (1941) obtained more rapid and complete germination and a more even stand of seedlings from ponderosa pine seed stratified for 30 days at 34° to 40°. He cited certain disadvantages of using stratified seed, including poorer handling by mechanical sowers, less accurate control of sowing rates, and injury to the seed by acid treatment of the beds after sowing. The germination of loblolly and shortleaf pine is much improved by cold, moist stratification for 30 days at 30° to 41° (Wakeley 1954).

White spruce, including that of Black Hills origin, shows strong dormancy, while that for blue spruce was moderate to nonexistent. Good germination of these species was obtained after 50-day stratification at temperatures from 34° to 49° F. (Cram 1951).

Germination of Arizona cypress seed is usually very low, probably because of the poor quality of seed produced commercially and possibly also because of seed dormancy. Cold stratification in peat moss for 20 days is recommended.[7]

The erratic germination of juniper seeds commonly used in Plains planting has long been a problem in private nurseries. Seeds of eastern redcedar have dormant embryos which require 100 to 120 days of stratification at 35° to 40° F. to afterripen (Pack 1921, Taylor 1941). In a series of tests to determine the most favorable temperatures for afterripening, Barton (1951) found that 41° gave the best results, that 33° was less effective, and that 50° was totally ineffective. Germination was arrested in afterripened seed for as long as 3 months by storing ungerminated seed at 15° to 20° (Afanasiev 1955). Germinating seed was injured by the subfreezing temperatures, and it did not resume growth after storage. A reduction in germination occurs if seed is allowed to dry after stratification and before sowing (Afanasiev and Cress 1942a).

Dormancy of the seed of Rocky Mountain juniper is essentially the same as that of eastern redcedar except that chemical changes during afterripening are slower and normally require 14 to 16 months after seed maturity for free germination without pretreatment (Afanasiev and Cress 1942b). Beds of this species have lain over without germination for 1½ years from the time of fall seeding despite depulping and 3 months of stratification at controlled temperature. Hence, it seems best to keep this species in stratification for 6 months before seeding in the spring. Then it usually germinates 2 to 3 weeks after seeding.

The presence of impermeable seedcoats in a large percentage of juniper seed will prevent complete germination. Seedcoats may be made permeable by exposure to moisture at a temperature of approximately 25° C. (77° F.) for 2 to 3 weeks. Soaking for 30 minutes in concentrated sulfuric acid is also effective; this treatment is given before the seeds are placed at low temperatures for breaking the dormancy of the embryos (Barton 1951).

Scarification has been used to increase the permeability of juniper seedcoats. Mechanical scarification of the seed in a steel drum lined with sandpaper was used successfully at the Bessey Nursery as early as 1934 (Dayharsh 1934). A more efficient type of scarifier, consisting of six vertical sandpaper-covered disks, was useful for small experimental lots of seed (Stoeckeler and Baskin 1937). For larger lots of seed, where comparatively light scarification is needed, a modified Ames scarifier can be used (Chapman 1936).

The methods used to induce germination of juniper seed and the results obtained have varied depending on location. In some places one method will produce even, prompt germination, whereas the same procedure used elsewhere will not. The two species, eastern redcedar and Rocky Mountain juniper, may also react differently. The two methods commonly used are planting the seed in the fall shortly after collection and planting in the spring following stratification.

Consistently prompt germination of eastern redcedar in Oklahoma has been obtained in fall sowing (Engstrom 1950, 1955). The clean, depulped, unstratified seeds are sown about December 10, covered with one-eighth to one-fourth inch of sawdust, watered, and then covered with 0.002-gage (thickness) polyethylene film. The film is in 1,000-yard rolls and is 53 inches wide. Burlap is laid over the plastic film, and both are pinned

[7] U.S. Forest Serv. Fourth Ann. Rpt., Fiscal Year 1957, Region 8, Eastern Tree Seed Testing Laboratory.

to the soil at intervals of about 4 to 6 feet with 5-inch soil staples made of No. 9 wire.

Germination starts about March 1 and is completed by March 10 to 15. As soon as germination starts, the burlap and plastic film are removed from the beds, snow fence is rolled out on the 1- by 6-inch bedboards to provide half-shade, and the burlap is laid on top of the half-shade for 10 days. The burlap conserves moisture and guards against early spring freezes. In one instance, air temperatures dropped to 12° F. without harm to the seedlings. With this method, redcedar seed completes germination about 3 weeks earlier in the spring than does seed covered only with burlap. Favorable results are also obtained when it is used with Austrian and ponderosa pine.

Fall sowing of eastern redcedar is also being tried experimentally at the Bessey Nursery. The cedar berries are collected as soon as they are ripe and are depulped. The seeds are dried just enough to permit drill seeding, sown, covered with burlap, and mulched with straw or hay. Germination has been sufficient to produce good stands the following spring.

At the Mandan nursery of the Soil Conservation Service, October sowing of *Juniperus* produced uniform germination from 1946 through 1949. Seed of Rocky Mountain juniper was stratified at 45° to 50° F. for a 4-month period prior to sowing, while that of eastern redcedar was sown dry. After seeding, the beds were mulched with a 4-inch layer of straw and shingletow and watered until freezeup. The mulch helped to prevent (a) winter drying when snow cover was absent, (b) alternate freezing and thawing, and (c) premature germination in the spring.[8]

SELECTION OF THE NURSERY SITE

Successful planting of conifers in the Plains begins with the selection and development of the nursery site. This decision is a prime factor in determining the quality and cost of the planting stock. In fact, the success or failure of the nursery may depend on the site selected. Once the nursery is established, a change in location is difficult and expensive.

The Plains have an essentially adverse environment for growing coniferous seedlings. Common problems are excessive alkalinity of soil or water, water shortages, poor internal drainage and crusting and baking of some soils, lack of mycorrhizal fungi, wind erosion, frequent winter injury, frost heaving, hail, heat injury, much damping-off, and damage by rodents and birds. These are a formidable array of difficulties for those planning to grow conifers in the Plains. All sites have some problems. Therefore, one with the fewest adverse factors must be chosen.

The major considerations in the selection of a nursery site are the soil and the water supply. Other important items requiring attention are the availability of markets, utilities, and labor; the shape, topography, and size of tract; and the crop history of the land.

SOIL

A suitable soil in the nursery is a prime requisite since the characteristics of the soil influence almost every nursery operation, from sowing the seed to shipping the stock. Soil texture, soil fertility, its reaction, and its alkalinity are discussed in this section. All aspects of the management of the nursery soil are discussed in detail in a later section.

Soils with textures that would be considered somewhat droughty for dryland farming are the ones best adapted to conifer seedling and transplant culture. The irrigation equipment, an essential feature of any Plains nursery, will overcome a trend to droughtiness, which is an inherent feature of all soil profiles with properties desired for a conifer nursery.

The surface and subsurface layers of soil to a depth of at least 10 feet should be sands, loamy sands, or light sandy loams. Good internal drainage is necessary, since alkalinity problems, especially upward movement of alkalies from evaporation, are at a minimum in such soils. Areas with tight soils or with clay bands in the substrates must be avoided. So too must extremely coarse, gravelly substrates, which permit a high loss of irrigation water.

In terms of mechanical analysis, the top 12 to 24 inches of soil should have a silt-plus-clay content between 12 and 35 percent, with subsoils preferably in the 5 to 20 percent range. Tests can readily be made with a field test kit (Wilde and Voigt 1955) or performed for a fee at the soil testing laboratory of the State agricultural college.

Commercial nurserymen growing balled and burlapped stock prefer somewhat finer textured soils for their lining-out beds, used for the second and successive transplantings. Soils may be loams or even silt loams, with a silt-plus-clay content of as much as 60 percent. Such lining-out tracts receive less watering than seedling or "first transplant" beds; hence, the salinity problem is not as critical.

Sandy soils have advantages over the heavy soils for seedling and transplant culture. They have better water intake and better soil-air-moisture relationships; they crust less, can be worked sooner after rain or irrigation, have fewer alkali problems, and produce more fibrous root systems (Anderson and Cheyney 1934, Howell 1932). The trees can be lifted, dug, and transplanted with less power and less damage to the rootlets. The disadvantages of sandy soils are their need for more frequent watering, their lower fertility, and their greater subjection to wind erosion.

The initial nutrient level of the proposed conifer nursery site before fertilization, particularly for areas devoted only to seedlings and transplants, can be somewhat lower than is desirable for farm crops. More important is the need for a friable, deep, rather porous, slightly acid soil free from harmful alkalies. Such soils

[8] Personal communication with A. E. Ferber, Soil Conservation Service, Denver, Colo., August 1960.

are likely to be deficient in available phosphorus. They may also contain less total nitrogen and organic matter than is necessary for conifer production. But these deficiencies can be remedied by means described in the section on "Soil Management."

The pH of the prospective nursery site is quite likely to be 6.0 to 7.2 for soils that have not been irrigated. Use of soils with a pH of 7.5 or higher, especially those of fine texture, is almost certain to result in insoluble or very costly problems of pH adjustment, due to an excess of carbonates and alkalies. (See Engstrom and Stoeckeler 1941 and Richards et al. 1954 for more discussion of this problem.) However, for nursery blocks that produce balled and burlapped stock from transplanted seedlings, satisfactory growth has been obtained in soils with a surface pH as high as 7.8, such as in the High Plains of northern Texas near Lubbock, where oriental arborvitae, various junipers, and some of the drought-hardy pines are being produced.

Use of soils with more than 500 p.p.m. (parts per million) of total soluble salts has created difficulties in the growing of pines and spruces, owing to chlorosis, excessive damping-off, crusting of salts on the surface due to evaporation of irrigation water, and phosphate and other nutritional unbalance.

WATER SUPPLY

Most States have laws on water use, particularly on the pumping of water from lakes, streams, and reservoirs. Some States require registration of pumps drawing irrigation water from wells. The State Geologist can provide information.

Experience has shown that irrigation water for use in Prairie-Plains conifer nurseries should have less than 200 p.p.m. of total dissolved solids (Engstrom and Stoeckeler 1941). For sensitive crops, as defined by the Salinity Laboratory at Riverside, Calif., the sodium adsorption ratio of the irrigation water should be under 10 and the boron content less than 0.5 p.p.m. (Richards et al. 1954). Most conifers grown in the Prairie-Plains are in the sensitive-crop category, so these criteria should be considered approximate permissible maximums. In nurseries devoted to the growth of balled and burlapped stock, where the water need is less than for seedbeds or transplants, water with as much as 400 to 500 p.p.m. of dissolved solids has been used. Higher amounts may be permissible with proper periodic soil treatments, such as acidification.

Even though irrigation water meets the above specifications, alkalinity problems can still occur. Continued irrigation for several years may result in an unsatisfactory condition in the soil surface. An example is the water supply at the Towner Nursery, Towner, N. Dak. Analysis at the time of nursery establishment showed 187 p.p.m. of total dissolved solids in the irrigation water. Two years of heavy watering raised the average reaction (pH) of the soil surface from 6.5 to 7.5, and seedlings of sensitive species began to show the effects. Stunting, patchiness, poor stands, and a low percentage of plantable trees were observed in some beds. The condition was readily corrected with acidifying materials.

Water drawn from wells may be somewhat less alkaline than surface water taken from streams, and it is also free of weed seed. Moreover, salinity of water in some streams tends to increase as the river stage drops; at this time water needs in the nursery may be quite high.

The irrigation water required depends on the size of the nursery, its latitude, relative acreage of seedbeds and transplants, amount and distribution of rainfall during the growing season, method of irrigation, stand density, protection by windbreaks, and amount of shade on seedbeds. Nurseries in the Southern Plains often need more water than those in the Northern Plains. Nurseries in the Western Plains require more irrigation water than those farther east, where the rainfall is higher. Flood or furrow irrigation requires more water than sprinkler irrigation. More water will be needed in abnormally hot seasons such as occurred in 1936.

During years of normal precipitation the total irrigation water needed for nurseries growing both seedlings and transplants is estimated to be as follows:

Location	*Annual supplemental water needs (inches)*
Northern Plains	10–15
Central Plains	15–25
Southern Plains	25–30

In years of abnormal heat or drought, 5 to 8 inches must be added to the above amounts. Most nurserymen will prefer to have a water system with a capacity sufficient to water the necessary area in daylight hours, and a surplus capacity for watering on a round-the-clock basis in seasons of drought or extreme heat. A flow of 450 gallons per minute is equivalent to 1 acre-inch of water per hour.

For nursery blocks devoted to balled and burlapped stock spaced in rows 40 to 80 inches apart, a capacity of 10 to 20 gallons per minute per acre is ample.

For sprinkler irrigation, per-minute capacities of 50 and 30 gallons of water per acre of seedbeds and transplants, respectively, are sufficient. Extensive use of flood irrigation will require 30 percent more water.

AVAILABILITY OF MARKETS, UTILITIES, AND LABOR

The nursery site should be close to, or slightly south and east of, the market center of the area to which stock is to be shipped. The warmer climate to the south permits lifting of the stock when the planting season opens. If other factors are equal, the more easterly locations have the advantage of greater rainfall.

The nursery location should have good access to

railroad, highway, telephone, and telegraph facilities. The type of planting stock distribution anticipated naturally has a bearing on transportation needs. However, since deficiencies cannot be remedied easily, adequate service at the start is virtually essential. The nursery must be on an all-weather road. Electric power is almost a necessity for light, seed and planting stock refrigerators, and other miscellaneous needs.

There must be an adequate supply of labor near the nursery site. The amount of labor needed varies widely, depending on the size of the nursery, the extent of mechanization, the degree of chemical weed control, and the amount and kind of stock grown. For about 6 weeks in the early spring, when labor needs are at a peak, about 2.0 laborers are required per acre of nursery seedbed and 1.5 laborers per acre of transplants. For 2½ months in late spring and early summer, the average requirements may be about 1.5 laborers per acre. And for about 3 months in late summer and fall, the requirements are 0.75 laborer per acre. The average required for this 7-month period is about 1.3 laborers per acre. Women and girls may constitute as much as 30 to 50 percent of the labor force and often do most of the transplanting, grading, and counting of stock.

SHAPE, TOPOGRAPHY, AND SIZE OF TRACT

Ideally the nursery tract should be square or rectangular; the long dimension should not be more than twice the short one. However, the best site available may be a long, narrow tract. An efficient layout is more difficult to obtain on such a piece of land, but the disadvantages can be minimized by careful planning.

A level tract with stone-free, deep loamy sand or light sandy loam soil is desirable. Such sites are most often on a stream terrace or glacial lake bottom. If furrow irrigation is anticipated, the land should have a gentle slope in one direction, preferably 0.1 to 0.2 percent on fine sandy loams, and slightly more for loamy fine sands. On very sandy soils, which absorb water rapidly, slopes up to 0.5 or 1.0 percent have been successfully irrigated in furrows. On land with more slope, it may be necessary to lay out the beds on contours with terraces.

Existing wind protection can often be used in choosing a nursery site. Natural or planted trees or situations favored by local topography may reduce the need for, or time required to obtain, adequate protection.

The tract must be large enough to meet immediate and preferably long-range production goals. Space calculations also must consider the need for cover and soil improvement crops in the rotation.

To compute nursery acreage needs per million trees for any specific age class, the probable production of usable trees per square foot of seed and transplant beds must be known. An average of 40 usable seedlings or 5 usable transplants per square foot of bed is a reasonable assumption for Prairie-Plains conditions. On this basis the net space requirements per million trees produced will approximate those in table 4. Other seedling and transplant densities may be used similarly in determining net space requirements of individual nurseries. For example, where seedlings are field planted directly, an average need of 30 trees per square foot might be assumed.

TABLE 4.—*Net space requirements per million trees of seedlings and transplants, excluding paths and roads* [1]

Age class of stock	Acres required for—					Total
	1st year	2d year	3d year	4th year	5th year	
1–0	0.57	.....	.....	.....	.....	0.57
2–0	.57	0.57	.....	.....	.....	1.14
3–0	.57	.57	0.57	.....	.....	1.71
1–1	.57	4.59	.....	.....	.....	5.16
2–1	.57	.57	4.59	.....	.....	5.73
1–2	.57	4.59	4.59	.....	.....	9.75
2–2	.57	.57	4.59	4.59	.....	10.32
3–2	.57	.57	.57	4.59	4.59	10.89
2–3	.57	.57	4.59	4.59	4.59	14.91

[1] Figures are based on 40 plantable seedlings and 5 plantable transplants per square foot.

The gross producing area of the nursery should be three to four times the net space requirements. An area of this size allows for paths, roads, and other nonproduction areas, and for cover crops in the rotation. Additional space must be allowed for windbreaks.

The minimum size for nurseries producing several million seedlings and several million transplants is 20 to 40 acres in actual tree production, with 10 to 20 additional acres in reserve or cover crop.

CROP HISTORY OF LAND

The class of land most likely to be selected for a conifer nursery site is former farmland. Such land is usually free or nearly free of the more serious noxious weeds such as quackgrass and field bindweed. Areas that have been in intertilled crops are more amenable to immediate sowing of seedbeds than are those formerly in small grain or hay crops. The weed problem in the latter areas is likely to be serious for several years.

There may be tracts of grassland, pasture, or wild hayland suitable for nursery development. These generally would not be suitable for tree production for about 2 years after breaker plowing. They should preferably be summer fallowed for 1 year and planted to an intertilled agricultural crop the second season. Only then is the soil likely to be in good enough condition for nursery production.

More rarely, abandoned agricultural land with suitable topography and reasonably adequate fertility,

but with a somewhat droughty nature, may be used. It may have been abandoned because of its droughtiness. However, if other factors are favorable, if the area has good internal drainage, adequate topsoil depth, proper soil texture, and an adequate supply of water of the desired chemical properties, it may be considered a potential nursery site. But the weed problem would probably be so serious as to require 2 years of development by the method described for grassland.

DEVELOPMENT OF THE NURSERY SITE

After the nursery site has been selected, it must be developed. Physical data on soil and ground relief characteristics must be obtained during or immediately after acquisition for use in planning the development. Careful groundwork will lessen the need for costly future alterations.

An accurate map with a scale of 1 inch to 50 to 100 feet should be made. On this map the layout of the water system, roads, windbreaks, and buildings can be diagrammed. A topographic map with a contour interval of 0.5 to 1.0 foot is useful in leveling and other necessary ground fitting. If flood irrigation is planned, such a map can be used to determine the location of the main ditches or flumes and grassed waterways. It also can provide the basis for subdividing the nursery.

SUBDIVIDING THE NURSERY

The site selected for a nursery is usually smooth, but there are always some small humps and minor depressions that need to be leveled. Where the cut or fill is more than 3 or 4 inches, it is desirable to stockpile the topsoil, perform the leveling, and replace a normal cap of topsoil on the disturbed area (Mony 1935).

Trash, straw piles, scrap lumber from old buildings, and other debris should not be burned on any area to be devoted to the growing of trees. Experience has shown that trees grown on the burned areas are more subject to damping-off, and growth is depressed, at least on the first crop.

On land with more than a 1-percent slope, the nursery should be subdivided on the contour. The degree of slope and the type of irrigation to be used determine the specific pattern. A system of broad-base terraces should be developed at intervals of 100 to 150 feet. The vertical interval may be 1 to 3 feet. At Norman, Okla., hedge windbreaks were established on the downhill side of each terrace. At most nurseries, slat-wire snow fences are preferred, since they occupy less space, can be readily moved, and harbor no disease or insect pests as living hedges sometimes do.

Terraces in areas where rather high-intensity rains occur should have some grade. Those at the State Nursery at Norman, Okla., have a grade of about 1 percent, with a vertical interval of 2 feet between terraces. The spacing of terraces, both horizontally and vertically, and their rate of fall depend on the infiltration rate of the soil, steepness of slope, crop, length of terrace, and facilities for disposal of runoff water.

Agricultural engineers have worked out detailed guidelines on the development of terraces, and numerous publications with data of local or regional application are available. The technicians of the Soil Conservation Service have helped many nursery personnel lay out a system of terraces and grassed waterways.

On level land, the irrigation system to be used is the chief factor in subdividing the nursery. A common basic subdivision is rectangular, 400 to 500 feet long and 250 to 500 feet wide. A subdivision of this size will accommodate the standard overhead irrigation system. Where portable surface-pipe irrigation with rotary sprinklers is to be used, distances from the riser to the end of the line may be 700 to 900 feet.

DEVELOPING THE IRRIGATION SYSTEM

The type of water supply that should be developed depends on the volume required for irrigation. The choice is often dictated by the quantity and quality of the water available on the nursery site.

The nurseryman must determine the best method of pumping and distributing the water. The type of pump and motive power to be used will depend on the quantity needed, the pressure desired, and the depth of the water table.

However, most nurseries in the Plains depend upon wells as a source of water. Deep wells cost more to develop and pump than shallow wells, except possibly where artesian pressure is available.

A few nurseries pump from streams and ponds. Open water sources are usually less costly to develop than wells. Several wells and pumps are better than a single one, which may break down or fail occasionally. Where multiple installations are made, they should be far enough apart to avoid overlap of their cones of depression under sustained pumping.

Well points may be adequate for small nurseries but are not recommended where a large quantity of water is required. Because of the frequent fluctuations in the depth of the water table due to long droughts and the heavy drain upon the underground water supply, it is difficult to maintain a satisfactory water level in the ordinary shallow well or battery of well points. However, this difficulty can be overcome by increasing the depth of the well as the water table drops or by constructing a deep well equipped with a turbine pump.

Most nurseries use deep-well turbine pumps to obtain their water supply. These should be installed on a contract basis, with a guarantee of development of

a specific minimum amount of water per unit of time under sustained pumping of 8 or more hours.

Centrifugal pumps are satisfactory where water is pumped out of streams or shallow water tables. The suction lift should not be more than 15 feet, and 5 to 10 feet is preferred. Shallow wells are often cased with perforated steel pipe, and coarse sand and gravel are placed next to the intake to accelerate inflow of water and to reduce the rate of clogging of the screen with finer sand particles. Details of casing a well are given in Agricultural Handbook 110 (Stoeckeler and Jones 1957) and in numerous State college publications on irrigation and well development (Duffin 1955, Fischbach et al. 1957).

There are three general types of irrigation; use is made of (1) overhead pipelines, (2) sprinklers with a portable surface pipe, and (3) furrows or flooding. The overhead system is the type most widely used nationally in coniferous nurseries. It is usually the standard against which other systems are compared.

The overhead system, which is convenient and simple to operate, consists of a series of parallel pipes spaced 52 to 53 feet apart and resting on pipe supports at 12-foot intervals (fig. 13). Nozzles are spaced at 2- or 3-foot intervals on the pipe. When this system is in operation, oscillators driven by the water pressure turn the 200- to 500-foot lengths of pipe through an arc sufficient to water a strip about 28 feet wide on each side of the pipe.

Water is distributed efficiently, and maintenance costs are relatively low. The primary disadvantages are the high initial cost and rather incomplete coverage obtained when winds are blowing. Both the underground and overhead piping must be carefully planned and installed to assure top performance.

F-325967

FIGURE 13.—Installation of the 1936 expansion of the Towner Nursery water system. Note mains and risers, cross trenches across future roadway at left for risers to be installed in opposite side, and the long, parallel overhead lines shortly to be placed in the pipe supports.

F-475078

FIGURE 15.—A portable sprinkler irrigation system at the Oakes Nursery, Oakes, N. Dak. The pipe is of 4-inch diameter and is in 20-foot lengths, and the sprinklers are 40 feet apart. One well supplies 13 sprinklers; each throws 13 gallons per minute. There are three wells on the 40-acre tract. Note the excellent wind protection afforded by the dense one-row planting of Siberian elm, 25 feet high 20 years after planting.

The surface-pipe sprinkler system consists of an underground water main to which lightweight, quick-coupling metal pipes are attached (fig. 14). Each section of pipe is 20 to 40 feet long, and rotating single- or double-nozzle sprinklers are installed at 40-foot intervals (fig. 15). Lengths of 600 to 700 feet may extend from the underground water mains.

The nozzle sizes used in the rotating type of sprinkler should generally be one-eighth or three-sixteenths inch in diameter, especially for first-year seedbeds; nozzles of larger diameter throw so much water that there is much undesirable splash and soil movement in the beds. For second-year seedbeds and for transplants, larger nozzles would be permissible since soil splash is not as serious a problem, even with nozzle sizes putting out as much as one-half inch of water per hour. The usual capacity of sprinkler heads used in conifer nurseries is 9 to 18 gallons per minute.

The initial cost of the surface-pipe sprinkler system is less than that of the overhead system. This method is more flexible and therefore better adapted to the smaller nursery. But it is less convenient. Distribution of water is not as uniform. Splashing and soil movements are likely to be greater problems.

More details on sprinkler watering, estimates of water needs, and other aspects of irrigation are available in publications by Fogel (1957), Monson (1952), Monson et al. (1953), Thorfinnson et al. (1955), Wiersma (1955, 1956), and Woodward and Gilden (1955).

Flood or furrow irrigation should only be used as a supplement for the sprinkler systems in conifer nurseries. The porous soils required for best conifer production cause uneven distribution of water, excessive

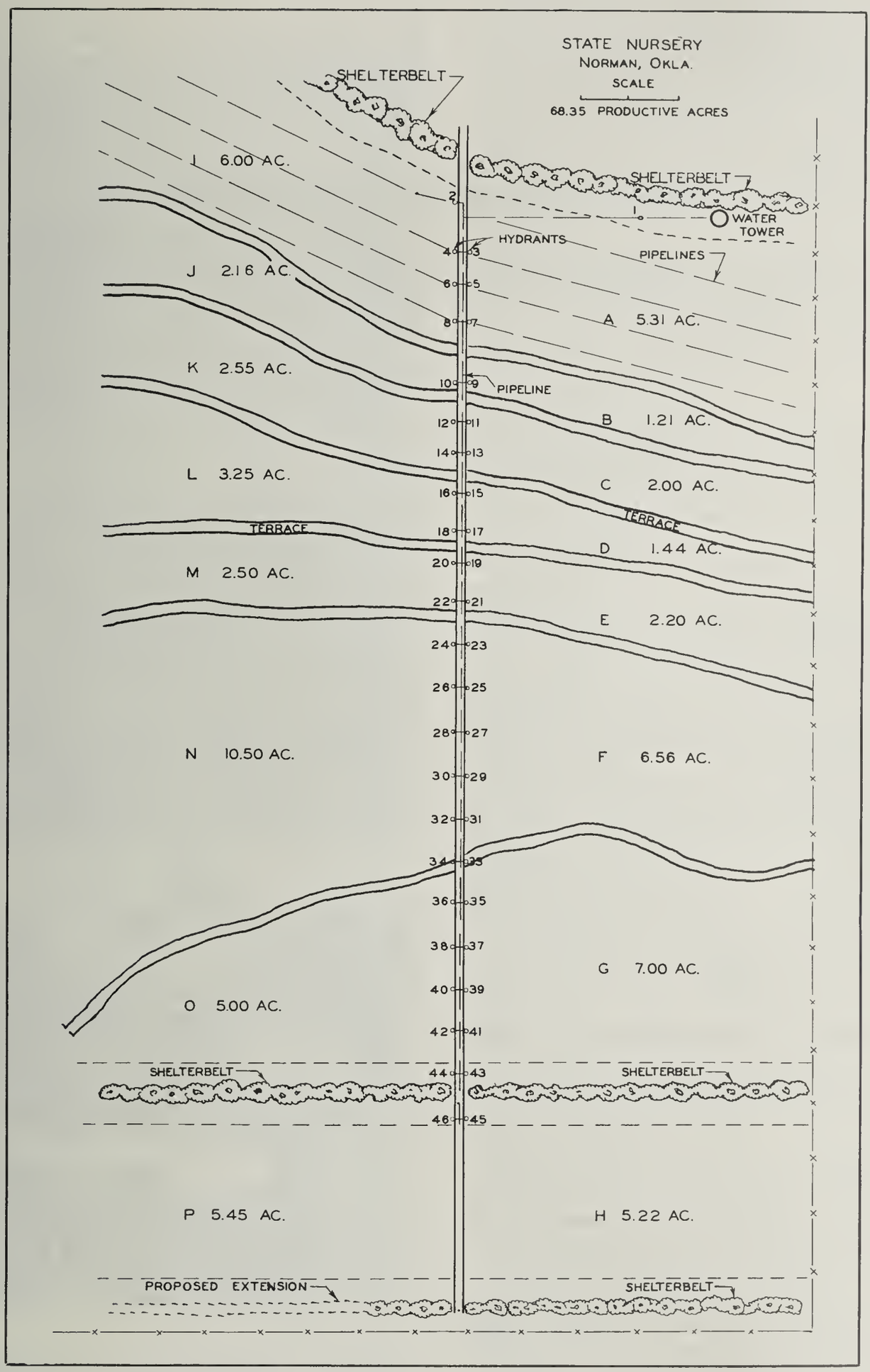

FIGURE 14.—Sprinkler irrigation system layout used at the Oklahoma State Nursery at Norman. Surface pipes of 4-inch diameter are laid on the contour between terraces from hydrants. The main pipeline is 8 inches in diameter.

water use, and leaching of soil nutrients. Also, flood irrigation is less apt to produce the fine fibrous root system desired on pines.

Under some circumstances, flood or furrow irrigation may be a convenient means of watering transplant beds or second-year seedbeds. Straight rows are preferred to contour rows because of the greater ease of layout.

SEEDBED PREPARATION AND SOWING

Ordinary farm equipment—tractors, plows, disks, and harrows—is used to prepare the soil for seedbeds, transplant beds, or cover crops. The choice of equipment will depend on the size of the nursery, comparative costs, and the personal preference of the nurseryman.

Both wheel and crawler-type tractors are used in Plains nurseries. The heavy jobs in the larger nursery will require a tractor of about 35-drawbar horsepower. A light unit of 15 to 18 hp. is suitable for the lighter jobs or as the basic power unit for the small nursery. Tractors equipped to use two- or three-point suspension implements are more maneuverable and versatile.

Rotary tillers are used at a few Prairie-Plains nurseries for ground preparation. They do an excellent job of incorporating manure, peat, and compost into the soil. However, they tend to pulverize the soil too finely, leaving it more subject to wind erosion.

As part of soil preparation, small patches of weed pests such as quackgrass can be spaded out carefully by hand, or eliminated by repeated use of a potato digger, quacker, or rotary tiller (Clifford 1934). If a rotary tiller is used, the hinged rear cover is folded so as to throw soil and roots a maximum distance. After use of any of the three machines, the roots are raked and picked off the surface. Especially heavy patches of quackgrass or other noxious weeds can be eliminated by use of chemicals such as methyl bromide, ammonium trichloracetate, or sodium trichloracetate. The manufacturers' instructions should be followed carefully. Sources of information on nursery machinery, equipment, and chemicals are given in the Appendix.

STAKING OUT AND PREPARING THE BEDS

After the seedbed area has been worked down and leveled, 4-foot-wide beds are staked out. Where overhead irrigation is to be used, 10 beds usually are spaced between the pipelines. The space next to the pipeline is usually 18 inches wide, and the nine paths between the 10 beds are 12 inches wide. Some nurseries use only nine beds in order to allow more path width. Stakes are set at each end of the bed, and binder twine is stretched between them to maintain alinement.

The final fitting of seedbeds is done by one of several methods. The object is to secure a smooth, slightly crowned, or flat bed. The paths are usually made a few inches lower than the bed centers. Mechanized equipment has superseded hand methods, reducing manpower requirements per unit of land prepared for seeding. A commercial seedbed shaper (Story 1940), or some adaptation of it (fig. 16), is used at the larger nurseries.

A method suitable for small-scale operations involves the placement along each bed of two 1- by 4-inch bedboards spaced 44 inches apart inside. The bedboards are held down with inverted **U**-shaped strap iron stakes (Robbins 1935, Stoeckeler and Jones 1957). The bedboards serve as a track on which to slide the bed leveler (fig. 17a). The simple device consists of a piece of 1- by 8-inch board 43 inches long; a piece of 2- by 4-inch wood about 2 feet longer than the 1- by 4-inch leveling blade is placed on both sides of the board. To reduce wear on the leveler, a steelplate is placed on the bottom of the leveler where it rides on the 1- by 4-inch bedboard. Once beds have been sown, dry, sandy nursery soil is sifted over them, and they are again leveled, with an adjustment for varying the depth of seed covering.

Seedbeds may also be prepared with a smoother

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FIGURE 16.—A tractor-mounted bed shaper which forms and levels a seedbed in one operation. Bessey Nursery, Halsey, Nebr.

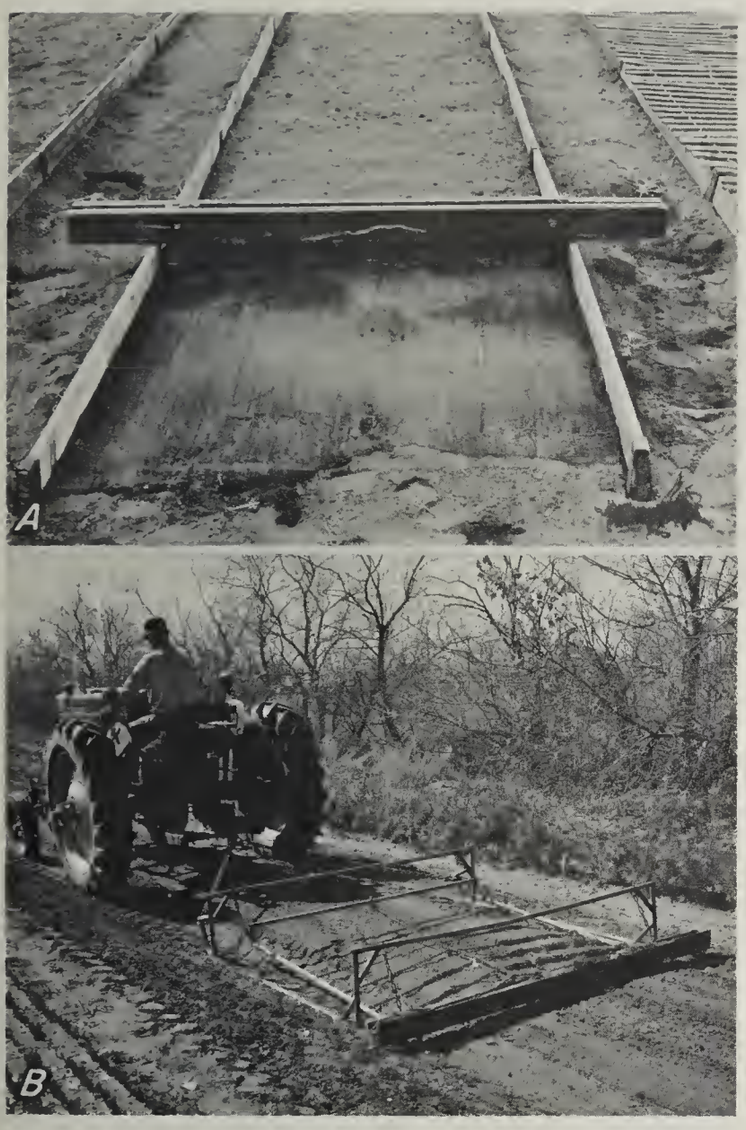

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FIGURE 17.—Two methods of seedbed preparation: *A*, a simple and effective float suitable for use on 1- by 4-inch bedboards; *B*, a seedbed smoother in operation.

(Futrell 1959) or a 4-foot-wide drag (fig. 17b). Drill seeding is done directly on this prepared bed.

In all bed preparation some hand touchup of the beds is necessary. The surface of small spots which has become excessively smooth or "shiny" is slightly roughened with push brooms or springy-tined leaf rakes just before seeding so that light seed will remain in place after broadcasting and before the seed covering is applied.

In some nurseries rollers are used to firm the seedbeds prior to sowing; other nurseries depend on the walking done on the beds while they are being smoothed, raked, or leveled. Rollers are also used to press the seed lightly into the soil after the beds have been seeded and covered. In large nurseries where seeding has been mechanized into one operation in which only one machine is used, the roller has been made an integral part of the seed drill.

COMPUTING THE AMOUNT OF SEED TO SOW

Seed should be sown on the basis of a specific weight of seed per unit of area to secure desired seedbed densities and to prevent seed wastage. Laboratory tests should be used to determine the germination percent. For freshly collected seed such as juniper, which may have to be fall-sown in the same season it is collected, a cutting test should be used to provide an estimate of quality.

The amount of seed to sow can be estimated by the following formula:

$$P = \frac{A \times D}{G \times S \times Y}$$

where P = pounds of seed;
A = area in square feet;
D = desired density in number of seedlings per square foot;
G = germination percentage of the seed, expressed as a decimal;
S = number of seeds per pound at time of seeding; and
Y = survival factor expressed as a decimal.

The survival factor (Y) is the percentage of the viable seed that survives to the transplantable seedling stage, whether that be the 1–0, 2–0, or 3–0 age. It varies greatly by species and nursery and drops with increasing age of the seedling (table 5). The survival factor can be determined only after data are obtained from germination tests, cutting tests, sowing rate tests, and bed inventories.

Seedbed density has a marked effect on stock quality, seedling size, cull percent, and efficient use of seed. It can be varied so that the maximum number of trees suitable for transplanting or direct field planting are produced. The experience and judgment of many nurserymen indicate that pine and juniper seedlings to be transplanted should be grown in broadcast-sown beds at a density of 50 trees per square foot, and that spruce intended for transplanting (2–0 and 3–0) should be grown at densities of not more than 100 trees per square foot. For drilled spruce seed the density can be reduced to 60 to 75 trees per square foot. In some of the Southern Plains States, conifers shipped from the nursery are fieldplanted as seedling stock, usually as 2–0. Such trees are grown at a density of 30 per square foot.

Fifty years ago Pearson (1914) recommended seedbed densities for ponderosa pine of about 75 per square foot. Higgins (1928) evaluated the seedbed density of ponderosa pine in terms of the lowest cost per surviving 2–1 tree in the field. He favored a seedbed density of 75 trees or less per square foot (table 6). Wahlenberg (1929) studied ponderosa pine under a range of densities from 80 to 275 trees per square foot and found 80 to be best. The stem diameter decreased 0.1 millimeter for each 44-tree increase per square foot. After

TABLE 5.—*Survival ratios for several species and age classes of stock at two Plains nurseries*

Species	Towner Nursery		Mandan Nursery[1]	
	1–0	2–0	1–0	2–0
Blue spruce	0.43	0.39	0.50	0.30
Ponderosa pine	.73	.63	.68	.60
Rocky Mountain juniper	.70	.62	.53	.50
Scotch pine	.57	.45	.....	.....

[1] Formerly operated by the Soil Conservation Service.

2 years in the field, the stock planted as 2–0 had a 1-percent decrease in field survival for every 15-tree increase in seedbed density. Current practice is to sow for 50 pine trees per square foot.

The number of 1–0 seedlings that survive in relation to the number of seeds that germinate also is influenced by seedbed density. Higher tree survival factors are obtained when medium-to-low seeding densities are used. In an experiment at Towner, N. Dak., with ponderosa pine, a medium seeding density of 112 seeds per square foot resulted in a 66-percent survival of 1–0 seedlings (fig. 18).

TABLE 6.—*Nursery performance, and second-year field survival and cost of 2–1 ponderosa pine as affected by nursery seedbed densities*

Trees per square foot of seedbed (number)	Average weight per tree	Nursery cull	Survival in transplant bed	Second-year field survival of transplants	Final cost of 1,000 surviving trees
	Grams	*Percent*	*Percent*	*Percent*	*Dollars*
76	3.98	5.4	89	75	4.48
95	3.88	7.5	88	67	5.05
121	2.88	9.4	88	62	5.52
141	2.60	11.1	85	61	5.62

TIME OF SEEDING

The time of year to seed conifers depends on the tree species, growth rate, and, to some extent, nursery location.

Seed dormancy and optimum germination temperature vary by species. Species having seed with embryo dormancy or a combination of embryo dormancy and impermeable seedcoat are fall sown, or they may be spring sown if the seed is first subjected to cold stratification. Those with impermeable seedcoats but no embryo dormancy are preferably spring sown after the prescribed pretreatment for rendering the seedcoat permeable.

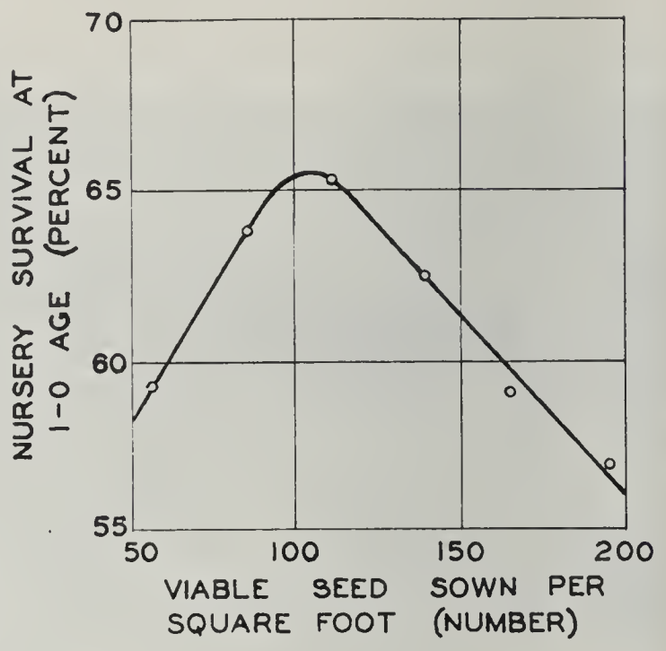

FIGURE 18.—Relation of first-year survival percent in ponderosa pine seedbeds to amount of viable seed sown per square foot. Towner Nursery, Towner, N. Dak.

Because of the longer growing season available to them, fall-sown seedlings commonly are larger and better developed at the end of the first season than are spring-sown seedlings. This differential growth of fall- and spring-sown beds can be used to produce seedlings of the desired size for field planting or for transplanting.

Local climate must also be considered in setting the time of seeding, particularly for fall sowing. Premature germination, with subsequent freezing and mortality of seedlings, can be avoided by delaying seeding to a time when unseasonable warm temperatures are less apt to occur. Coverings with insulating qualities, such as clean straw or marsh hay, can be applied to fall- and spring-sown beds to delay germination in the spring. With the above reservation, spring seeding should be done as early as the ground can be worked to allow the seedlings the maximum growing period.

Emergency late-season seeding (early summer) subjects the seedlings to high air and ground temperatures during germination and early growth, and frequently results in high mortality.

Eastern redcedar is sown in the fall after pretreatment. Seed of the current year depulped and cleaned with a lye solution usually germinates promptly the following spring. Rocky Mountain juniper is handled similarly but with less consistent results.

Most pine seed is sown in the spring. This is the general practice for ponderosa pine throughout the Plains. Promptly germinating species, such as jack, Scotch, shortleaf, Japanese red, and Japanese black pines, are also spring sown. Sometimes, to even out the nursery workload, ponderosa pines and other pines are fall sown. White pines, such as limber pine or Swiss stone pine, should be sown in the fall; if stratified seed is used, they should be sown in the spring.

Ponderosa pine in some Dakota nurseries is too small for transplanting as 1–0 and somewhat too large as 2–0. By delaying the seeding to about the first half of June, a 1½–0 tree about the right size for transplanting is produced. Such summer seedings must be watched carefully to avoid heat injury to the tender seedlings in midsummer. They may require not only shading but also more frequent light sprinklings to reduce soil surface temperatures. Summer seedings of ponderosa pine have also been used at the Bessey Nursery.

Spruce seed of dormant lots should be sown in the fall. However, if the seed are nondormant or stratified, they may be sown in the spring. In North Dakota [9] and Wisconsin (Jones 1934), white spruce seed sown in the fall germinates more promptly and completely than that sown in the spring.

BROADCAST VERSUS DRILL SOWING

Drill sowing has generally replaced broadcast seeding by hand in Plains nurseries, since it is more economical. It eliminates the cost of sand covering and permits mechanical cultivation.

However, broadcast seeding results in a more uniform distribution of seed, better mutual protection of seedlings, quicker formation of a complete ground cover, and more rapid suppression of weeds (Arnold 1956, Meines 1939). Brewster and Larsen (1925) found a 20-percent higher stand in broadcast beds than in drill-sown beds of ponderosa pine, both sown with equal amounts of seed.

At the Towner Nursery, in a controlled experiment, no significant difference was found between the two seeding methods in ponderosa pine beds grown at an average density of 59 trees per square foot. The average tree percent, based on viable seed sown, was 95.1 for drill-sown beds and 86.4 for broadcast-sown beds. At the 2–0 stage it was 66.2 and 65.6, respectively; the average fresh weight of 30 trees was 24.3 and 26.3 grams, respectively. All drill sowing was done by hand at carefully regulated seeding depths (fig. 19).

Spruces generally are regarded as better suited to the broadcast-sown beds than the usual drill sowings, since the depth of cover can be controlled more closely for broadcast seed. However, the best of the machine drill sowing should approach the control obtained by the hand method.

Research has shown no clear-cut advantage for either method in the quality and quantity of seedling stands produced, and the choice by the nurseryman will doubtless be influenced more by other considerations, such as the area of seedbed to be sown and equipment available for seeding.

SEEDING EQUIPMENT

Seeding, except on small-scale operations, is done with mechanical seeders which place the seed in rows

[9] Personal communication with John Molberg, Associate State Forester, Bottineau, N. Dak.

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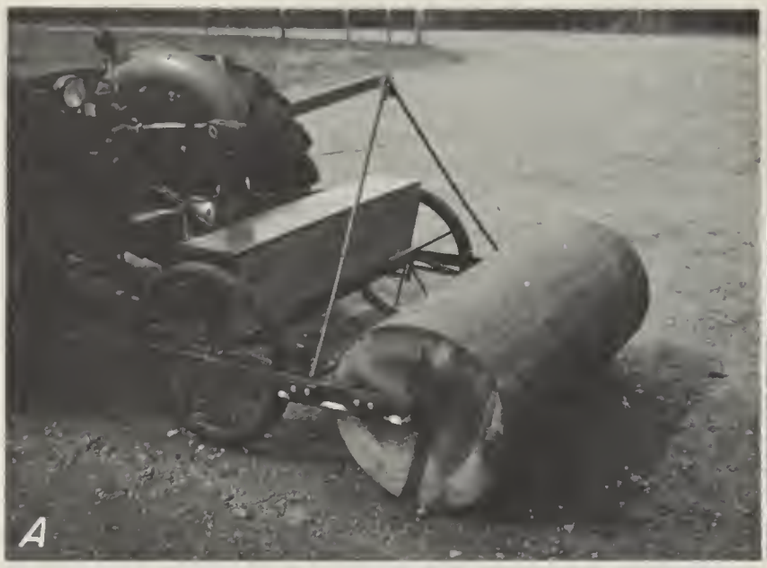
FIGURE 19.—Two- by four-foot experimental beds after use of hand method of drill seeding. The drills were made by tamping the 10-cleat frame in the background into a level, newly prepared, loose, moderately moist bed. The cleats are three-fourths by 1 inch. Seed is covered by hand or with the back of a rake drawn parallel to the drills.

or broadcast over the seedbed. Some seeders are manufactured commercially (fig. 20, *A* and *C*), while others may be built in a nursery shop from individual grain drill units assembled in batteries of 7 to 10 drills per 4-foot-wide bed (fig. 20*B*).

A lawn seeder is sometimes used. It is simply a V-shaped trough with adjustable openings in the bottom, which feed out the seed at a specific rate. A shaft rotor in the bottom is turned by the forward motion of the seeder and keeps the seed stirred up and feeding properly. The seed is covered by a mechanical sander. The seeder broadcasts seed over a full 4-foot-wide bed, and can successfully handle seed as small as white spruce (200,000 per pound) and seed sown to obtain 75 trees per square foot.[10] This seeder is especially suitable to small nurseries with a production of a few hundred thousand trees or less per year.

A second type of seeder, one with a 10-spout seeder, can be used for drill seeding (if equipped with 10 individual drill openers and closers), or can be adapted to broadcast seeding by letting the seed drop on a baffleboard placed at approximately a 45-degree angle to make the seeds bounce and slide toward the back, as the seeder is pulled forward (fig. 20*B*). It may be hand drawn or pulled by tractor. The seeder may run

[10] Personal communication with Robert Heintz, formerly Nursery Superintendent, North Dakota State Nursery, Towner, N. Dak.



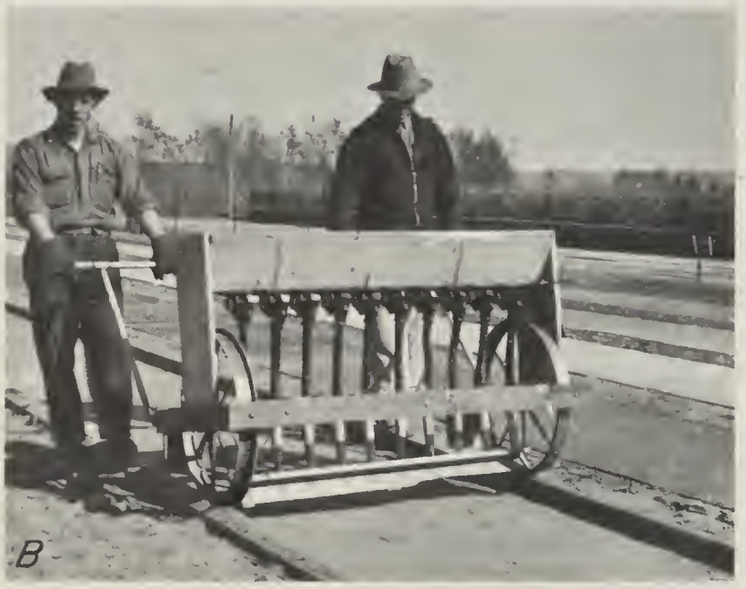


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FIGURE 20.—Several types of seeding machines suitable for 4-foot-wide conifer beds: *A,* A seeder used in combination with a roller; *B,* modified grain drill with 10 tubes, here used for broadcast seeding; *C,* eight-drill seeder-roller combination, Big Sioux Conifer Nursery, Watertown, S. Dak. *C,* (Courtesy of S. Dak. Dept. of Game, Fish, and Parks.)

on wooden tracks or on the smoothed soil of the seedbed path.

Seeders that sow and cover the seed in one operation are more commonly used than the preceding types. These sow the seed in drills the length of the bed. One or two flat rollers are incorporated (fig. 20*C*); these perform the final smoothing and firming of the seedbed and drive the seeding apparatus. The seed is fed from a common hopper through modified grain-seeding tubes to the seeding assemblies. Each assembly consists of an adjustable furrow-opening shoe and a furrow coverer. Packing wheels firm the soil in each drill row, before and after seeding.

On another type of seeder, two corrugated rollers are mounted rigidly in tandem, with one slightly offset from the other. The seed is fed into the sharply defined furrows formed by the first roller. It is then covered by the action of the second roller, which splits the ridges formed by the first roller.

All seeders can and must be adjusted to put out a specific number of seeds per square or lineal foot of drill. The usual procedure is to lay down a large canvas and, after making an approximate adjustment, to draw the seeder over it for a specific distance; the amount of seed laid down per unit of area is then counted and weighed. Adjustments are made until, after a few trials, the right amount of seed is laid down. The seeder is then ready to sow that specific lot of seed. Frequent checking is needed as seeding proceeds to make sure that each drill is feeding, that no refuse is clogging the feeding mechanism, and that the seed hopper or hoppers have enough seed to maintain a uniform flow.

COVERING THE SEED

After the seed is sown, a uniform depth of covering is needed for even germination of seed and a uniform stand of seedlings. Deep sowing makes emergence more difficult and increases the possibility of injury from damping-off fungi.

The proper sowing depth depends upon seed size, soil texture, and the season of sowing. The common practice is to sow the seed of the larger seeded species such as ponderosa pine at a depth of one-fourth to one-half inch and that of the finer seeded species at one-eighth to three-sixteenths inch. The seeding depth can be about one-third greater in the light sandy soils than in the heavier loam soils because of the greater ease of seedling emergence in the sandy soils. Seeds should be sown slightly deeper in the fall than in the spring to insure adequate covering of the seed in beds exposed to frost action and wind erosion.

The sowing depth recommended for ponderosa pine is supported by research. Show (1917) found that

one-half inch cover was quite satisfactory. Brewster and Larsen (1925) found that on comparable plots under northern Rocky Mountain conditions, the number of seedlings obtained according to cover depth was as follows: one-fourth inch, 680; three-eighths inch, 650; one-half inch, 600; three-fourths inch, 550; and 1 inch, 470.

Trials at the Towner Nursery in North Dakota, in a considerably drier area than mentioned by the above investigators, showed the germination of ponderosa pine to be dependent both on depth of seeding and whether burlap mulch was used (fig. 21). Two seed lots of different germinative energy were used. The best stands with both seed collections were obtained with one-fourth to five-eighths inch depth and a burlap mulch. At three-fourths inch and deeper, the stand count for seed with a burlap mulch dropped very rapidly. Apparently under burlap, surface drying of beds is not as severe as in unmulched beds, and a very thin soil or sand cover suffices. However, when no burlap mulch was used, one-fourth inch proved too shallow a cover, and the unmulched seed in a considerable range of sand depth (three-eighths to three-fourths inch) gave better stands.

Managers of Prairie-Plains nurseries on sandy soils generally use drill seeding and thus avoid the need to cover the seed in a separate operation. However, in nurseries located on heavier soils there are excellent reasons for using broadcast seeding with peat, sand, or sawdust as a seed covering to avoid crusting. Straw mulches have been used in some nurseries, but one-fourth inch of sawdust was reported to be more effective (Clifford 1955, Knight 1958); it has the advantages of being free of weed seeds and not requiring removal (Allison and Anderson 1951). Whatever covering is used, seed that is broadcast sown should be pressed slightly into the soil with a roller before covering.

Sand to be used as a cover should be thoroughly tested to see that it is at least slightly acid. The test is made with a few drops of 10 to 20 percent hydrochloric acid. If the material fizzes, the sand is not desirable for use as a cover, since it is likely to increase damping-off disease.

Sands that are acid or neutral in reaction are scarce in the Great Plains, especially in the western part. Sands from subsurface layers of soil, which are more free of weeds and disease, tend to be even more alkaline in reaction. Some dune sands in the Plains may be leached of carbonates to a depth of 4 to 6 feet; these are suitable as seedbed covers. In areas of extensive heavy soils, sometimes the only suitable sandy material is in the surface 6 to 10 inches of the sandiest field that can be found.

Where no acid sands are within easy hauling distance of the nursery, Davis (1940) suggests that in lieu of using alkaline sands, the nurseryman drill sow, surface sow with burlap mulch, or broadcast sow with sawdust as a seed cover.

If straw or any type of hay is used, it should be as free as possible from weed seed. If such material is hard to obtain, the nurseryman could well grow some rye or oats in the nursery and mow it before seed has formed in order to assure a supply of mulch free from weed seed (fig. 22).

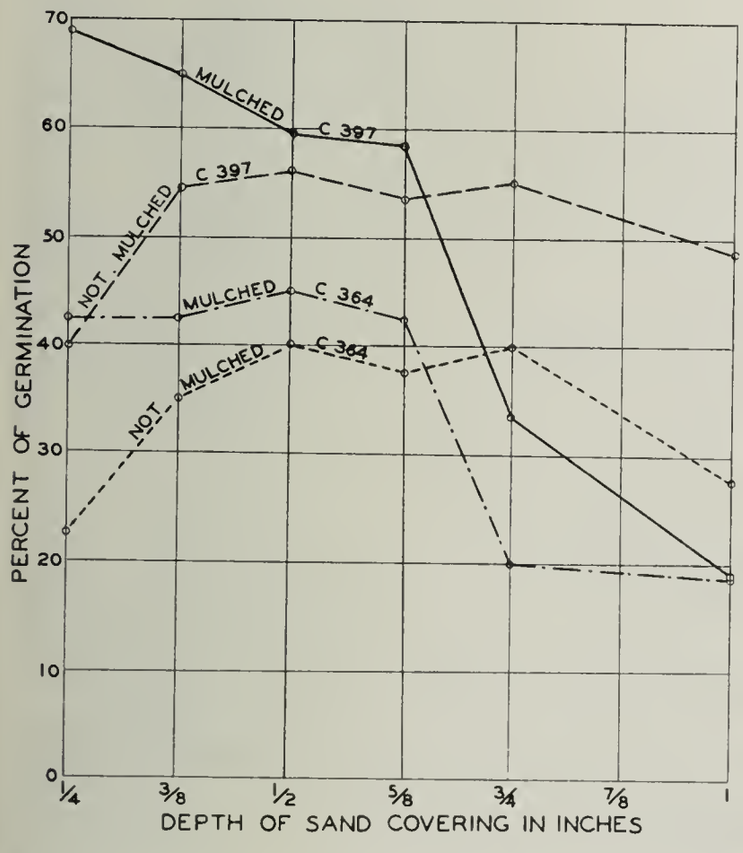

FIGURE 21.—The effect of depth of covering and use of burlap mulch on the germination of ponderosa pine seed, Towner Nursery, Towner, N. Dak. Two seed collection lots were used; the numbers on the trend lines designate these lots.

F-502091

FIGURE 22.—Application of a layer of straw on top of cotton commodity cloth in fall-sown beds, Bessey Nursery, Halsey, Nebr.

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Mulch applied to fall-sown beds serves the following purposes:

1. It conserves moisture and reduces soil drying and cracking.
2. It prevents fall germination by reducing soil temperatures at seeding depth.
3. It retains soil temperature in the 33° to 50° F. range longer, and by preventing soil freezing in late fall or early winter, it provides a longer period of afterripening under conditions similar to controlled temperature stratification.
4. It reduces soil blowing and uncovering or deep burial of seed.
5. It prevents early spring germination.

At least one commercially manufactured sand spreader is available for use on broadcast-sown beds. However, most nurseries use homemade devices. A simple one consists merely of a frame, 2½ by 3 feet, with the long sides extending a foot or more beyond each end to make the handles. The bottom of the frame is covered by ¼-inch-mesh galvanized hardware cloth. Sand or sandy soil from the paths is shoveled onto the screen, which is shaken by two men.

A tractor-drawn endless-belt sand spreader was devised by Olson (1930). Bull (1954) describes a reciprocating sifter, suitable for sifting sand or sawdust, which is actuated by a camshaft and mounted on a trailer (fig. 23). The Savenac Nursery has devised an automatic trough sander, which is towed behind a dump truck from which the sand drops into the sander.

Any chemical treatments with liquid materials, such as acidification with dilute sulphuric acid or aluminum sulphate or postseeding weed-control drenches, should be applied after the seed is covered with sand or soil and before the burlap or any other mulch is applied.

F–505892

FIGURE 23.—A reciprocating sifter, Towner Nursery, Towner, N. Dak.

F–502093

FIGURE 24.—Pinning down burlap on newly seeded beds to conserve moisture and assure prompt, uniform germination, Bessey Nursery, Halsey, Nebr. Burlap covering also prevents wind erosion. Looped pins of galvanized iron wire are preferred, as they can be re-used.

Newly seeded beds are commonly protected with covers between seeding and germination. Soil moisture levels favorable for germination can be maintained with less watering. Use of burlap has been quite successful with the more rapidly germinating pines, especially in spring seedings (fig. 24). More recently, polyethylene film has been employed as a bed covering; it has an outstanding ability to virtually preclude any moisture loss from the beds. Burlap alone does not do this well, especially on fall sowings. A combination of polyethylene film covered by burlap prevents tearing of the film by wind and, by reducing soil freezing, increases the time the fall-sown seed is exposed to the beneficial afterripening effect of soil temperatures in the 33° to 50° F. range.

The life of burlap is extended by treating it with copper naphthenate (Anderson and Kineer 1949). After use, it should be dried thoroughly, beaten to remove excessive soil, and rolled for storage. A special burlap reel can be used advantageously (Stoeckeler and Jones 1957).

Five stages of nursery operation, including preparing the seedbed, seeding, rolling, seed covering, and sifting sand, are illustrated in figure 25. The methods shown represent an intermediate stage of development of nursery equipment that gave an accuracy of depth control in seeding seldom achieved by the more mechanized methods now commonly used, especially in the larger nurseries.

SEEDBED CARE DURING GERMINATION AND THE SEEDLING STAGE

The seed germination stage of about 10 to 30 days is most critical because the tender seedlings are easily injured. Mulches must be removed in the spring after the danger of killing frosts has passed. If allowed to remain in place until germination is well advanced and after the seedcoats appear above ground, the mulch interferes with early growth, and its removal from the bed is accompanied by mechanical damage. Great care must be used in taking up burlap or in raking straw mulches from the seedbed. Fiber or wire-tined rakes are less damaging than ordinary garden rakes. Complete removal is desirable since losses of seedlings are apt to occur as a result of excessive moisture and the root rot disease favored by the decomposition of the mulch.

HALF-SHADE

Half-shade is needed in Prairie-Plains conifer beds, particularly by the more delicate and smaller seedlings during the first season. It is common practice to shade all species except ponderosa pine and occasionally Austrian pine. These two species are more heat resistant and are often grown without shade. Half-shade prevents heat and drought injury, reduces water use, and minimizes soil drying (Hartley 1918, Stoeckeler and Jones 1957, Toumey and Korstian 1942). When placed directly on bedboards, it also excludes rabbits and dogs. Any half-shade tends to confine the intrusion of larger mammals, such as deer, to the paths.

Four separate experiments at the Towner Nursery showed that no advantage was to be obtained by shading ponderosa pine during the first year. The trends, when analyzed separately for each experiment, were nonsignificant statistically, but the stands, as noted below, were consistently greater in the unshaded beds.

Experiment	*Plots* [1] *Number*	*No shade (trees per square foot)*	*Half-shade (trees per square foot)*
A	48	78.9	75.1
B	64	54.6	46.0
C	64	61.2	57.2
D	32	52.2	45.8
Average		61.7	56.0

[1] Size of plots: A, 4 by 12 feet; B, C, and D, 2 by 4 feet.

F-439905

FIGURE 25.—Various seedbed operations are illustrated here. Right background: preparing seedbeds and laying portable track. Center background: operating a 10-spout seeder, with seedbed roller following the seeder. Center foreground: operating a sanding machine. Right foreground: sifting sand with a slanting portable screen into sand-carrying tray.

Two experiments at the Towner Nursery compared the presence and absence of shade on the basis of tree percent of viable seed sown (fig. 26). Unshaded beds produced higher tree percents, except for high-density sowings in one of the studies.

Jack pine, however, does best under shade. In a study at the Towner Nursery, shaded beds consistently had a denser stand than unshaded beds and were substantially better at the higher rates of viable seed sown (fig. 27).

The advantages of shading are considered to be even greater with spruces than with jack pine, since the former are slower growing and more delicate than pine. Some nurserymen leave half-shade on second-year spruce until mid-September. The need for shade is somewhat dependent on the season of sowing and on watering frequency. Fall-sown seeds germinate more promptly than spring-sown ones. Trees, therefore, are larger and have thicker stems by early summer, and less heat injury occurs.

Almost all nurseries use slat-wire snow fence for half-shade. For high-shade, snow fence may be placed on two tightly drawn pieces of No. 9 wire supported on 30-inch posts driven into the ground with 1- by 2-inch crosspieces at intervals of about 12 feet (fig. 28). The snow fence is 12 to 20 inches above the ground. It must be wired together and drawn fairly taut at the ends. Some nurserymen take the additional precaution of attaching it to the No. 9 wire at intervals of about 25 to 30 feet to keep it from being thrown off the wires in high winds. If a third wire is run down the middle of the beds, upright supports can be at least 15 feet apart (Sharkey 1956).

Where bedboards are used, the snow fence is rolled directly on top of them. This lower shade is not quite as effective as higher shade because the strips of seedbed are exposed longer to full sunlight and there is less free air movement under the snow fence. Heat injury occurs occasionally when half-shade is positioned at a height of 4 or 6 inches.

A few nurseries use rigid shade frames. The Bessey Nursery, for example, uses individual 4- by 12-foot shade frames made of lath nailed to 2- by 2⅝-inch stringers—one on each long side. These shade frames are supported on each of the four corners by a piece of 1½-inch angle iron 3 inches long that has been welded to the top of a 22-inch-long five-eighths-inch bolt. The bolts are pushed into the ground about 6 inches.

SOIL MOISTURE AND IRRIGATION

The amount of water applied in a nursery will vary by water-holding capacity of the soil, annual precipitation, air temperature, humidity, wind, species, and age of stock. Each soil has a specific water-holding capacity, and only enough water need be added to raise it to field capacity. For sands, this value is about 8 to 12 percent; for loamy sands, 12 to 15 percent; for sandy loams, 15 to 25 percent; and for silt loams, 25 to 35 percent. Excessive watering tends to leach out soluble

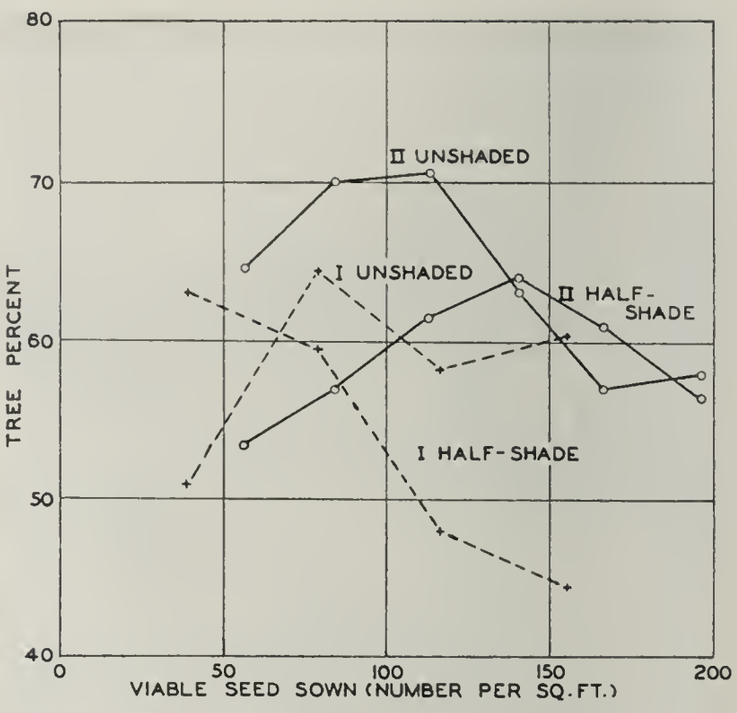

FIGURE 26.—Tree percent in 1–0 ponderosa pine beds in two separate experiments (I and II) in shaded versus unshaded beds over a range of sowing densities, Towner Nursery, Towner, N. Dak.

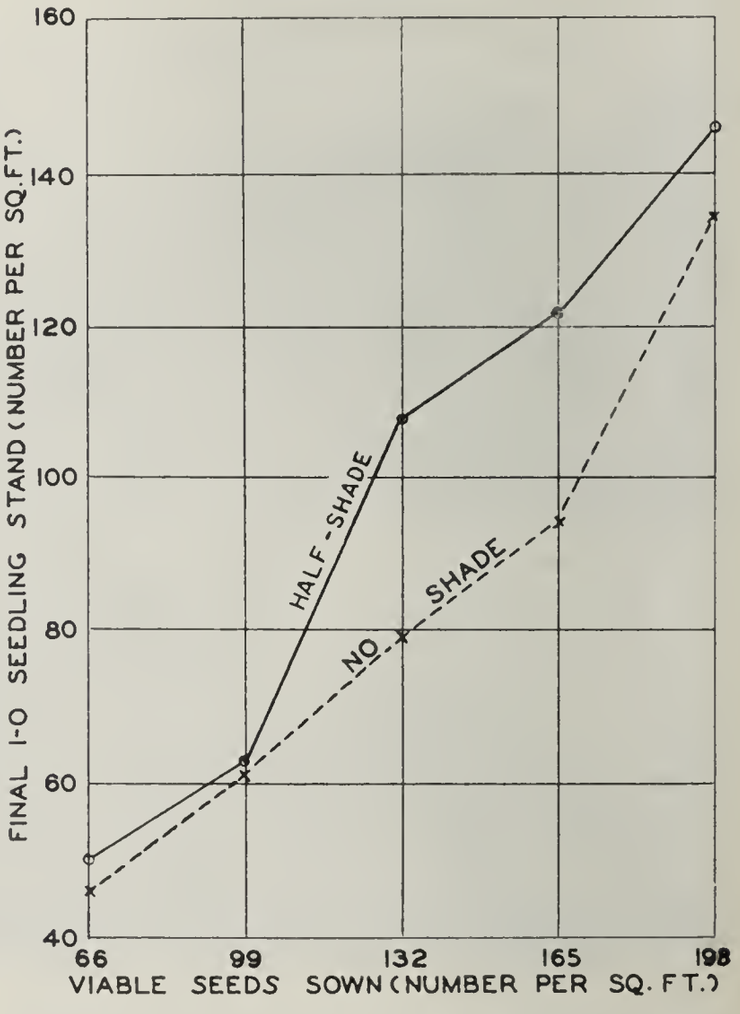

FIGURE 27.—Effect of half-shade on a stand of first-year jack pine seedlings over a range of sowing densities, Towner Nursery, Towner, N. Dak.

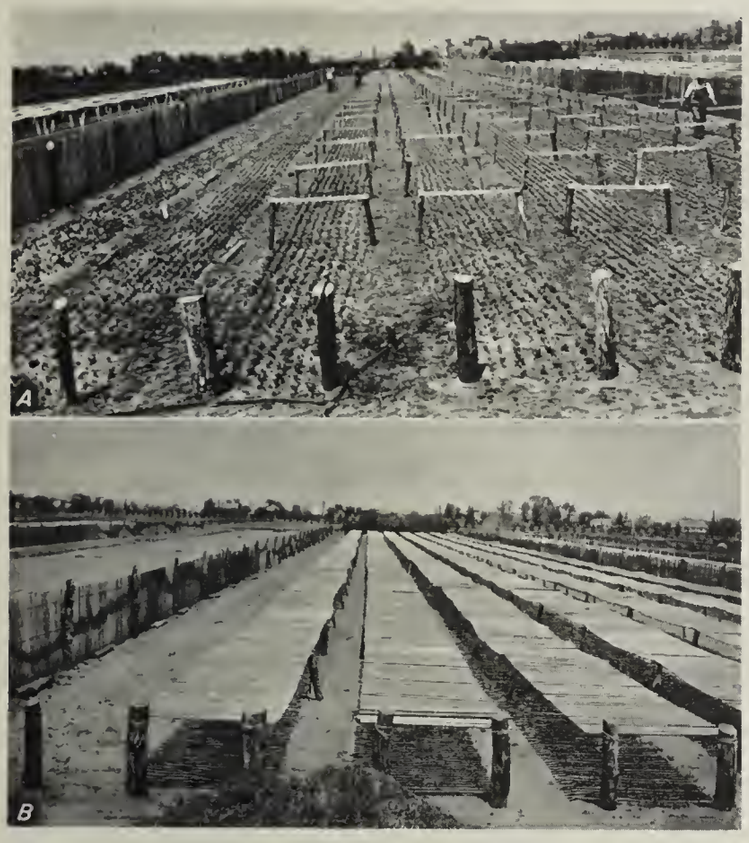

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FIGURE 28.—*A*, Round posts and crosspieces for half-shade support; *B*, the half-shade in position, Fremont Nursery, Fremont, Nebr.

nutrients, especially nitrogen and potash, and results in unnecessary use of water and power.

The amount of water to use on trees, particularly from midsummer on, or when the tree roots are at least 3 or 4 inches long, can be gaged by use of a tensiometer. This device consists of a porous ceramic cup fitted to a vertical aluminum or plastic tube to which is attached a sealed vacuum gage (fig. 29).

The entire system is filled with clean water, and the porous cup is buried in the soil in the rooting zone. Water moves through the porous cup to the soil until the tension or suction pull is equalized. The amount of pull is registered in the vacuum-gage dial pointer. The scale ranges from 1 to 100, and represents tension values from 0 to 1.0 atmosphere. Watering of beds is started as soon as the pointer gets into the 50 to 60 range. The tensiometer needs occasional filling with water. It may or may not be kept in one place, but about 8 hours must elapse before equilibrium is reached. Hence, it is desirable to have a tensiometer for first-year seedbeds, one for second-year beds, and another for transplants. If texture varies considerably, checks of moisture content must be made in several situations. Slight knolls that are exposed and very sandy soils will dry out faster than flat areas or those with a higher silt-plus-clay content (Stoeckeler and Aamodt 1940).

Soil moisture content can also be gaged by electrometric methods devised by Bouyoucos (1956) and Colman (1947), by oven drying or use of Livingston soil points (Stoeckeler 1939), or by the alcohol-burning method (Bouyoucos 1937).

Under nursery conditions, especially during active growth, soils should never be allowed to dry to the wilting point. Preferably they should have at least 2 to 3 percent of moisture in excess of the wilting point in sands and 4 to 5 percent in excess in sandy loams. Excessive soil dryness can weaken plants, while excessive watering tends to reduce drought resistance (Shirley and Meuli 1939, Stoeckeler 1951a). For example, where 2–0 jack pine were grown under four levels of watering in the nursery, optimum drought hardiness was achieved by those trees in seedbeds with an average available moisture content of about 5 percent from June 1 to September 15, or a total average soil moisture content of about 8.5 percent for a soil with a silt-plus-clay content of 10 to 12 percent (Stoeckeler 1951a). Among western species, Roeser (1940) determined that the water requirements of spruce and fir were considerably higher than those of ponderosa or limber pine.

Correct watering from germination to the time when root length is at least 3 or 4 inches and stems are moderately resistant to heat injury is difficult to gage instrumentally, and the nurseryman should rely on keeping the surface of the bed moist by light daily or twice daily watering. The ends of beds on the windward side may require hand watering with a hose. At the Bessey Nursery, first-year conifers are watered twice a day for the first 4 to 6 weeks; 0.15 inch is applied in the early morning and the same amount in the late afternoon. Thereafter, one watering is made per day, unless the beds are moist from rain.

Two-year-old stock requires watering about every 4

F–493114

FIGURE 29.—Two instruments for soil moisture determination. The soil mosture meter on the left works on the tensiometer principle; it measures comparative soil dryness in terms of suction pull of the soil. The moisture meter on the right gages soil moisture electrometrically by measuring resistance of current through buried gypsum blocks.

days, and transplants at least once a week; enough water is applied to soak the soil to an 8- to 10-inch depth. The amount required varies from 0.3 to 0.8 inch. In sand, 1 inch of water will wet the soil to a depth of about 1 foot (Woodward and Gilden 1955). The depth of wetting will depend on the soil moisture content when watering is started.

Near the end of the growing season, the trees are watered only once every week to 10 days to harden off the stock, reduce succulence, and increase frost hardiness. This hardening-off process begins in late August in the Northern Plains, in mid-September in the Central Plains, and in late September or early October in the Southern Plains.

WEED CONTROL

Weeds are a constant problem in nurseries and must be systematically eliminated by hand picking, by the use of hand-pushed or power-operated cultivators, or by the application of chemicals. Many nurseries use all of these methods.

Mechanical and Hand Weeding

In new seedbeds hand weeding is often used as a mopup operation after chemical weed control. Weeders may work in pairs on the same 4-foot-wide beds, each taking half the bed and working systematically from one end to the other, or each may have an assigned unit, consisting of one-fourth or one-half the length of the bed. The weeds are pulled by hand and dropped into boxes or collected later from piles in the paths. Deep-rooted, hard-to-pull, or persistent weeds, or those that break off, are dug out or cut off 1 inch or more underground with a steel cutter fixed into a loop attached to a wooden handle (Engstrom and Stoeckeler 1941), an old table knife bent into an L-shape (Tennessee Valley Authority 1954), or a similar handtool. Paths are cleaned with a push hoe or with wide sweeps attached to a rubber-tired tractor.

After the trees are about 6 weeks old, seedbeds sown in drills with a 4½- to 6-inch space between drills can be cultivated with power-drawn rotary weeders (McDaniel 1954, Mony 1954, Stoeckeler and Jones 1957, and Umland 1946).

Transplants in rows spaced 10 inches or more apart are usually straddle cultivated by a battery of ordinary farm cultivator shovels mounted on a tractor. In this operation, all the rows in a 4-foot bed are cultivated simultaneously. Where the row spacing is uniform and wide enough to accommodate a rubber-tired tractor, the rows can be cleaned with multiple-row cultivators to minimize damage to the trees. In transplant beds, four to six cultivations a year are needed to keep the weeds down.

Weeding should start when the weeds are quite small. Weeds 1 to 2 inches tall are eradicated much more readily than larger ones, and minimum damage to trees occurs. To reduce root breakage, beds should be made reasonably moist before weeding.

Chemical Control of Weeds

Chemical weeding is used much less in Plains nurseries than elsewhere. Wider use could reduce stock costs. Chemicals used rather extensively for weed control in forested areas include mineral spirits, allyl alcohol, and methyl bromide. Other chemicals being tested show promise. The generally rapid advance in the use of chemicals to control agricultural weeds is bringing additional benefits to nursery practice.

Safety rules and precautions for handling, mixing, and applying chemicals are given in the Appendix. All nurserymen should be thoroughly familiar with these rules and should see that adequate precautions are taken when any chemicals are handled.

Mineral Spirits

Mineral spirits are petroleum products that are used as selective herbicides in many conifer nurseries (Robbins et al. 1947, Stoeckeler 1951b and 1952b, Wycoff 1954). When used in proper amounts, they kill small broadleaf weeds and grasses without harming the evergreens. They can be purchased from most bulk gasoline distributors.

Undiluted mineral spirits are applied with pressure sprayers as a fine mist at a pressure of 50 to 100 pounds per square inch, generally at the rate of 25 to 75 gallons per acre (table 7). On a small scale they can be applied with a 1- or 2-gallon pressure sprayer. They are most effective if applied three to six times per season when the weeds are small, preferably about one-fourth to 1 inch tall. Taller and older weeds are more resistant to oil sprays.

TABLE 7.—*Dosages of mineral spirits used on conifer species in the north-central Prairie-Plains*

Species	Age		
	3 to 6 weeks	6 weeks to 1 year	1 year and older
	Gal./acre	*Gal./acre*	*Gal./acre*
Juniper, Rocky Mountain	25	30	40–60
Pines:			
Austrian	25	30	40–60
Jack	40	50	60
Ponderosa	25	30	40–75
Red	40	50	60
Scotch	40	50	60
Redcedar, eastern	25	30	40–60
Spruce:			
Blue	25	30	40
White	30	50	60
White (Black Hills)	25	30	40

The mineral spirits must be applied as a fine mist, and at a dosage reasonably near the optimum for the specific age class and species. The temperature at the time of spraying is also important. In the absence of

specific information from Plains nurseries, it is recommended that application should not be made when air temperature exceeds 80° F., a limit that has been found safe in Lake States nurseries. Trials conducted over a period of years have helped to determine effective applications at individual nurseries.

Mineral spirits were first used in the Bessey Nursery in June 1948. They were applied with a Bean sprayer at 200 pounds pressure, using about 50 to 80 gallons per acre on seedlings and 80 to 115 gallons per acre on transplants. Weed kill ranged from 50 to 100 percent.

Good kill was obtained on lamb's quarters, primrose, barnyard grass, crabgrass, foxtail, sandbur, fescue, and pigweed. The following species were rather resistant to the spray: Panic grass, rye, ragweed, pepper grass, sunflower, nightshade, sage verbena, plantain, clover, and wood sorrel.

By 1951, dosages as low as 25 to 50 gallons per acre, sprayed when weeds were quite small (usually less than 1 inch tall), were giving up to 90 percent weed kill. These lower dosages reduced weeding costs 35 percent. Injury to seedlings was generally small, although occasionally about 5 percent of the trees showed some temporary yellowing that usually disappeared within 1 month. Mortality has been under 1 percent, or less than that normally lost in ordinary hand weeding and machine cultivation.

Seedlings less than 6 weeks old are more subject to injury from mineral spirit sprays, and special precaution must be taken with them.

At the Oklahoma State Nursery, excellent weed control has been obtained by application of mineral spirits two or three times a season in amounts as low as 12 to 15 gallons per acre. The mineral spirits were applied as soon as the secondary foliage appeared on the seedlings. Eastern redcedar and Austrian, ponderosa, shortleaf, and loblolly pines are among the species sprayed.

If weeds have emerged but the tree seedlings have not, excellent control with complete safety may be obtained by spraying the weeds with 50 to 60 gallons per acre of mineral spirits.

Methyl Bromide

Methyl bromide is a gas injected under polyethylene film or gasproof cover before seeding. Developed for disease control in forest tree nurseries, it has been very effective as a weed control on seedbeds in which first-year seedlings are produced. It has virtually eliminated all weed growth for 22 days or more after the tree seed has been sown (Stoeckeler 1951c). In the usual treatment, 1 pound per 100 square feet of bed area is used; however, the dosage may vary from one-fourth to 1¼ pounds, depending on the kind and severity of weed infestation and the soil texture (Mony 1961). In tests at the Towner Nursery in North Dakota, one-half pound applications reduced weed numbers by two-thirds, a degree of control equal to that obtained with dosages of 1 to 1¼ pounds. Air temperatures should range between 50° and 80° F., and a high moisture content of the weed seeds is essential for control.

Total costs, which include those for labor, gas, and plastic covers with a 2-year life, have averaged $234 per acre in Indiana. This was 67 percent of the cost of other chemical methods and 50 percent of the cost of solvent oil and sulfuric acid methods (Mony 1961).

Allyl Alcohol

Allyl alcohol has had excellent effect as a preseeding treatment when applied about a week before seeding. Also, no covers are needed. It can be applied at the rate of about 10 gallons of the concentrated chemical in 5,000 gallons of water per acre (Maki and Allen 1952, Steavenson 1952, Stoeckeler et al. 1951). Experience in Plains nurseries is lacking. In small-scale operations, it has been applied in 0.2 percent solution by volume with sprinkler cans or acid sprayers. On large-scale operations, the safest method appears to be that of Lanquist (1951), who injects a 10-percent mixture by volume of allyl alcohol in water through the riser end of the overhead irrigation system. The mixture is injected at the rate of 50 gallons per 400 feet of pipeline; watering is then used to obtain further penetration into the soil.

Miscellaneous Chemicals

Zinc sulfate (Wahlenberg 1930) has been used as a postseeding drench, at 8 grams per 250 cubic centimeters of water per square foot of seedbed, and has given 80 percent weed reductions. However, some chemical injury has been reported in dry seasons or during water shortages; spruce has been especially affected (DeJarnette 1936). Sulfuric acid has given good weed control, and it is considered safer than zinc sulfate, because of the possibility of zinc toxicity.

A 4-percent solution of formaldehyde, at 1 gallon of solution per square yard, applied as a drench well before seeding, has given good weed and damping-off control (Holmes and Ivens 1952).

Simazine has been used successfully for weed control in Minnesota nurseries. Stadtherr and Coultas (1961) applied one-half to 1 pound per acre as a postemergent treatment to conifer seedbeds on a heavy loam soil. Application of 1 to 2 pounds per acre was used in the second year after transplanting. Two applications were made on the transplants, one in May and the other in mid-July to August. On sandy soils some injuries followed its application. This chemical may warrant small-scale trials under Prairie-Plains conditions.

Other chemicals reported successful as nursery weed controls are vapam, applied at one-half or 1 quart in 21 gallons of water per 100 square feet (Briscoe and Strichland 1956); ferbam, at 500 pounds per acre in 10,890 gallons of water (Allen 1952); and 2,4-D, at 6 pounds per acre, as a preseeding or preplanting control (Clifford 1952).

POSSIBLE HARMFUL EFFECTS OF CHEMICALS ON TREES AND SOIL

In recent years chemical corporations and research chemists have developed scores of new chemicals for weed, insect, and disease control. Overdoses of these chemicals or their cumulative effects may adversely affect tree stand, tree growth, or beneficial soil organisms (Gambrell and Heit 1952, Theigs 1955, Voigt 1953, Wilde and Persidsky 1956). The nurseryman is advised to use conservative dosages found by repeated trials to be entirely safe for the crop he is growing. Manufacturers' recommendations should be checked at State and Federal experiment stations.

If experiments are undertaken with chemicals still being evaluated, only small areas should be treated. Usually application should be limited to a few hundred square feet in the form of small replicated plots. At Towner Nursery, monuron (3-(p-chlorophenyl)-1, 1-dimethylurea), used as a preseeding treatment in a weed-control experiment, was deleterious to eastern redcedar. There was a 60-percent kill of trees at 1 pound per acre, 80 percent at 2 pounds, and 95 percent at 3 pounds. Experiments must be repeated for several years on areas of different soil textures since weather and soil moisture content affect the action of some chemicals.

A good point to remember is that organic matter in the soil has a counteracting effect on the harmful action of many biocides (Voigt 1955).

TRANSPLANTING

Transplanting is a standard practice in almost all Great Plains conifer nurseries. Its primary purposes are to produce more fibrous root systems, thicker, sturdier stems, and better balance between roots and tops. More food is stored, the enlarged stems stand erect, and the more fibrous root system absorbs more moisture and food from the soil. Such plants often have 20 to 30 percent better survival than seedlings.

Transplanting usually is done when the seedlings are 3 to 5 inches tall. Some of the factors contributing to a good transplant job are good soil tilth, a smooth, level bed, and accurate and regular row alinement.

The method of lifting the seedlings for transplanting is the same as that for field planting. It is described under "Digging, Grading, Packing, Storing, and Shipping." After lifting, the roots are pruned, in small bunches, to a uniform length, usually about 6 inches. The trees are then placed in boxes, ready for transplanting.

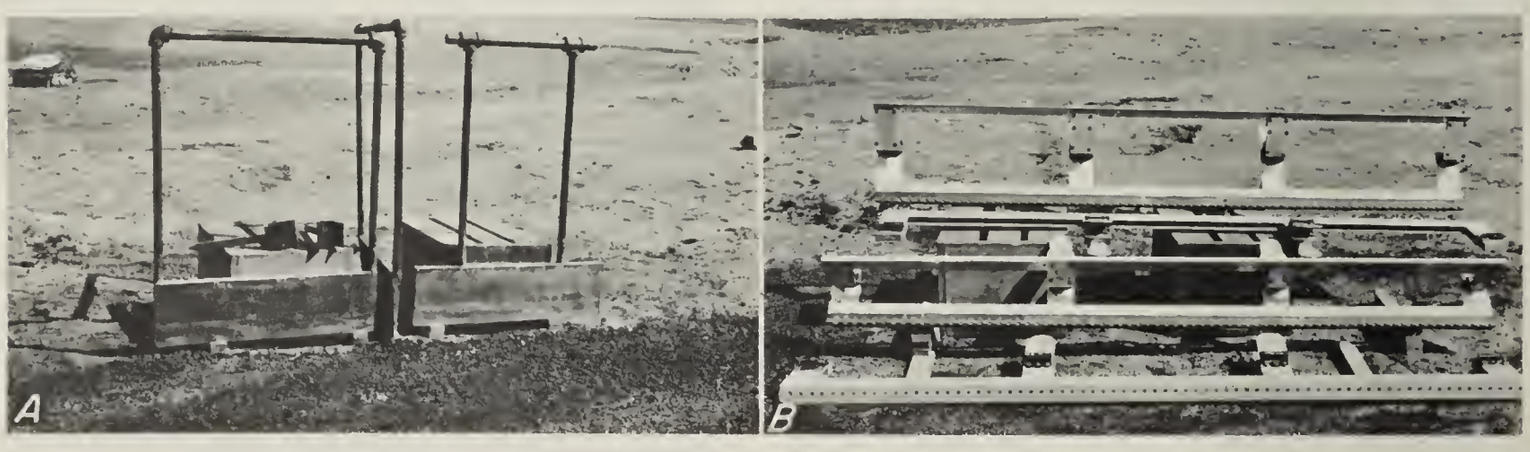
Both hand and machine methods of transplanting have been used. The method depends on the size of the nursery, soil texture, amount of transplanting to be done, and the funds available for mechanization. Some of the hand methods have been highly efficient, and under some conditions the production rate has been exceeded very little by using transplant machines. Whether hand or machine planted, the trees should be watered thoroughly on the day on which they are transplanted.

HAND TRANSPLANTING

Hand transplanting is done across the beds in short rows or lengthwise in continuous rows 100 to 500 feet long.

Trenches are made in the soil with a hand or tractor-drawn trencher. A hand-trenching tool consists of two thin steelplates welded together, sharpened at the bottom, and fitted with galvanized iron handles (fig. 30*A*). Several nurserymen have modified small garden plows or pony plows so they will make a vertical-walled open trench for transplanting in long rows with the conventional transplant board (Jones 1925, Corson 1935).

The trenches should be deep enough and wide enough to accommodate the tree roots in a vertical



F–361928, 361927

FIGURE 30.—Equipment for hand transplanting: *A*, Hand trenchers formerly used at the Bessey Nursery; *B*, details of the construction of an aluminum transplant board.

position without curling. Crossbed trenches should be about 6 inches longer than the transplant board. The proper amount of soil moisture will prevent the sidewall from sloughing or caving in, in the interval between trenching and planting. Coarse, unrotted plant residues will interfere with the formation of a clean trench; hence, such materials should be plowed under early enough to decompose or should be removed from the site.

Seedlings are threaded into transplant boards with notches 1½ to 2 inches apart (fig. 30*B*) (Fox 1940, Olson 1930, Schrader 1938). To protect the plants they are threaded inside a light, portable shelter. A hinged upper clamp on the board swings down to hold the trees in place while the board is carried to a trench. The tree roots should always be kept moist. The roots will be less exposed if the walking distance from the shelter to the transplant bed is kept less than 50 feet by moving the transplant shelters frequently or by assigning short sections of bed (about 60 to 100 feet) to each planter if the rows are long.

In planting, the board is lowered with a swinging motion—to and fro—in the trench and parallel to it. After the roots are hanging vertically, the board is adjusted for depth so that the trees are planted one-fourth to one-half inch deeper than they were in the seedbed (fig. 31). The trench is closed with the feet or a tamper; looseness around the roots must be prevented. Heel marks and depressions are smoothed by adding loose soil between the transplant rows.

When long boards (8 to 10 feet) are used, the transplant area must be exceptionally smooth and level so that all trees are placed at the proper depth. With a 10-foot board with 80 notches at 1½ inches, Oliver (1937) reported that an average of 8,600 trees per 8-hour man-day were transplanted in hand trenches across the bed. Olson (1930) reported using an 8.5-foot board with 75 notches, but the planting was done the long way of the bed in an open, vertical-walled trench made with a small 7-inch horse-drawn plow. The crew average was 11,000 trees per man-day. DeJarnette and Augenstein (1946) produced 11,500 trees per man-day by the same method. Six two-man crews were used; a threader and planter worked in each row.

At the Bessey Nursery, hand transplanting in recent years has been done with a 6-foot-long board containing 60 notches. A 20-man crew was employed; it consisted of 10 threaders, 5 planters, 3 trenchers, 1 tree carrier, and 1 foreman. Trenching was done by hand across the bed with a mast trencher 26 inches wide. One trencherman worked in each group of five beds, while each planter confined his work to three beds, planting each trench as it was opened by the trenchermen. Planting coops, each with two threaders, were kept within about 50 feet of the transplanting work. The crew planted 150,000 to 175,000 trees per 8-hour day.

Recently, the Bessey Nursery has started transplanting the long way of the bed. Each bed has seven rows spaced 7 inches apart; thus, the standard lifter for 4-foot-wide seedbeds can also be used on transplant beds.

F–406424, 365794

FIGURE 31.—Two methods of hand transplanting. *A*, Planting 1–0 eastern redcedar across the bed, using a board about 6 feet long; man in foreground is trenching and the man nearest him is firming the soil around the roots of the trees, Bessey Nursery, Halsey, Nebr. *B*, transplanting ponderosa pine in long, continuous trenches made by tractor-drawn trenchers; this method is well adapted to subsequent mechanical cultivation, Towner Nursery, Towner, N. Dak.

MECHANICAL TRANSPLANTING

Mechanical transplanting is accomplished with the Holland Seedling Transplanter, "New Idea" vegetable planter, or a similar type of machine. The so-called "mechanical transplanter" is not fully automatic. Each seedling must be handled individually and placed in a self-closing pocket on a revolving metal disk, or between two self-closing revolving disks. Normally two rows are transplanted at a time, but the number can be increased to seven (Hanks 1962) by mounting additional transplanting units on a special carriage (fig. 32).

The transplanting machine has many advantages; the chief asset is the elimination of the heavy manual labor involved in hand trenching and trench closing. Since mechanical trench opening and closing are combined in the same operation, the trench is left open to drying for an absolute minimum length of time.

F–504177

FIGURE 32.—Seedling transplanter used to transplant seven rows at a 7-inch spacing in one operation. The method permits the lifting of seven rows at a time with the same lifter used for seedbeds. It also permits efficient mechanical cultivation of seven rows at a time by a bed-straddling tractor. Bessey Nursery, Halsey, Nebr.

The tree roots are exposed to the air much less than in hand transplanting, where no protection of the threaded boards being moved from the transplant coops to the planting trench is possible. Transplanting can be done by crews of women; they are more nimble fingered than men in feeding seedlings into the planter. When the transplanting machine is used, less training, teamwork, or balancing of crews is required for maximum efficiency. Furthermore, the machine is geared to a specific speed (usually about 11 feet per minute), and the planters must keep up.

The trees are set by the mechanical transplanters 1½ or 2¼ inches apart in the row. The wider spacing permits trees, especially 2–2 or large 2–1 stock, to be separated with a minimum of root stripping when they are lifted. Batteries of transplanters pulled by one power unit may transplant two to seven rows during one trip over the beds. Uniform spacing between rows is obtained; thus, the trees are less likely to be damaged during later cultivation.

Transplant machines usually set about 10,000 trees per person per 8-hour day. Thus, use of these machines results in production only equal to or a little greater than that obtained by use of some of the most efficient transplant-board methods already mentioned, particularly those where long trenches are made by horse- or tractor-drawn trenchers. Mechanical transplanting has been widely adopted by the nursery industry, largely because of a shortage of labor for hand transplanting.

TRANSPLANT SPACING

Spacing within the transplant rows of at least 1½ inches is desirable. This interval has been determined from spacing experiments and general observations on stock quality, ease of separating roots, and freedom from root stripping.

Janouch (1927), studying spacing in 2–1 jack pine and in 1–1 and 2–1 ponderosa pine, concluded that 6- by 1½-inch spacing at the Bessey Nursery was nearly ideal and that 6- by 2-inch spacing was slightly wider than needed. He based these conclusions on subsequent field survival of the stock.

A comprehensive study of transplant spacing was initiated in the Towner Nursery in the spring of 1939 by personnel of the Lake States Forest Experiment Station. The species involved were ponderosa pine and Rocky Mountain juniper. Four spacings within the row (1, 1½, 2, and 4 inches) and four spacings between rows (6, 12, 18, and 24 inches) were tried in all possible combinations.

A sample of juniper stock was lifted and measured after 1 year in the transplant bed (table 8). Based on a caliper limit of one-eighth inch for a plantable tree, a spacing of at least 6 by 1½ inches, or 9 square inches per tree, was necessary to yield a fairly high percentage of plantable stock. The 2-inch space between trees had a marked advantage over 1½-inch spacing when row spacing was 1 foot or less.

When the juniper stock was lifted at the 2–2 age, the maximum production of usable stock occurred at the 6- by 1-inch spacing. All spacings gave at least 75 percent plantable stock. The top-root ratio was a little high, generally 4.0 to 5.0, which is not as good as it was at the 2–1 stage. The largest percentage of premium stock (using caliper as a criterion) was produced at a spacing of at least 12 by 2 inches.

Considering all factors of cost and performance, there seems to be no need for growing 2–2 Rocky Mountain juniper at a spacing greater than 6 by 2 inches. The usual spacing attained by mechanical transplanters should produce uniformly good stock but with less efficiency than that obtained with closer spacing between rows.

The ponderosa pine in the spacing experiment were all grown to the 2–2 age (table 9). The stock measurements showed that 6- by 1½-inch spacing produced good-sized stock of adequate height and stem caliper. All of the trees were slightly more top heavy than was desirable because of exceptionally favorable growing conditions in the fourth year.

The percentage distribution by stem caliper for 2–2 stock of two conifer species is given in table 10. Apparently, if a considerable proportion of the trees are to have a stem caliper of one-fourth inch or more, spacings of about 6 by 2 inches or larger are necessary.

TRANSPLANT LOSSES

In transplant beds, some of the trees die despite careful handling. To compensate for these losses, the amount of stock transplanted must be increased.

At the Savenac Nursery in Montana, the loss in ponderosa pine has been 3.1 to 30.0 percent (Fox 1937, 1939; U.S. Forest Serv., Rocky Mountain Region 1931) and is generally 10 to 20 percent. In the Northern Prairie-Plains, junipers and redcedars have had

TABLE 8.—*Effect of transplant spacing on size and grade of 2–1 Rocky Mountain juniper, Towner Nursery, Towner, N. Dak. The transplanting was done in the spring of 1939 and trees were measured in the spring of 1940*

Spacing (inches)	Average length		Average stem diameter	Green weight		Usable stock [1]	Premium stock [2]
	Top	Root		Total	Top-root ratio		
	Inches	*Inches*	*64ths inch*	*Grams*		*Percent*	*Percent*
6 by 1	11.0	11.1	9	21	3.2	73	17
6 by 1½	9.3	10.9	11	22	2.8	97	47
6 by 2	12.5	11.0	15	34	3.2	100	86
6 by 4	9.5	9.5	14	28	3.0	100	77
12 by 1	10.1	9.6	11	18	3.3	90	33
12 by 1½	9.5	10.0	12	28	3.0	93	61
12 by 2	9.9	9.5	15	33	3.6	100	80
12 by 4	11.0	12.3	17	30	3.4	100	97
18 by 1	9.5	8.9	11	41	4.9	87	43
18 by 1½	11.6	10.2	14	58	3.6	100	73
18 by 2	10.9	11.0	14	36	3.9	97	70
18 by 4	10.8	9.3	18	46	3.8	100	93
24 by 1	12.1	12.0	13	29	3.6	93	57
24 by 1½	9.7	9.8	13	29	3.5	97	70
24 by 2	9.9	9.0	14	33	3.4	100	70
24 by 4	11.0	12.4	17	56	3.7	100	97

[1] Trees with a stem diameter of at least 8/64 inch.

[2] Trees with a stem diameter of at least 12/64 inch.

TABLE 9.—*Effect of transplant spacing on size and grade of 2–2 ponderosa pine, Towner Nursery, Towner, N. Dak. The transplanting was done in the spring of 1939 and trees were measured in the fall of 1940*

Spacing (inches)	Average length		Average stem diameter	Green weight		Usable stock [1]	Premium stock [2]
	Top	Root		Total	Top-root ratio		
	Inches	*Inches*	*64ths inch*	*Grams*		*Percent*	*Percent*
6 by 1	7.2	12.3	16	26	4.3	100	50
6 by 1½	9.0	12.2	18	37	5.2	80	65
6 by 2	7.9	13.3	18	38	5.2	100	90
6 by 4	9.3	13.3	21	63	5.4	100	85
12 by 1	10.3	12.3	15	22	4.1	90	25
12 by 1½	8.5	15.8	18	45	5.3	90	75
12 by 2	8.2	14.3	20	58	4.8	100	95
12 by 4	8.0	14.6	20	59	5.0	90	75
18 by 1	5.8	13.5	15	24	4.1	90	45
18 by 1½	8.0	14.7	16	32	5.3	95	55
18 by 2	7.9	16.8	19	57	4.9	85	55
18 by 4	10.2	15.1	23	94	5.9	100	88
24 by 1	8.5	15.1	19	49	4.1	100	90
24 by 1½	8.8	15.8	18	50	5.5	90	60
24 by 2	8.8	15.7	21	72	4.9	95	70
24 by 4	8.5	15.0	21	63	4.5	95	80

[1] Trees with a stem diameter of at least 8/64 inch.

[2] Trees with a stem diameter of at least 12/64 inch.

losses of 5 to 15 percent; and spruces, losses of 15 to 25 percent. At the Bessey Nursery in Nebraska, losses in the first-year transplant beds have been about 10 percent, with a usual range of about 4 to 15 percent.[11]

[11] Personal communication with M. K. Meines, Nurseryman, Halsey, Nebr.

Each nursery must develop an experience table (see table 11) of first-year transplant losses by species and age class since season of transplanting, method of transplanting, and other factors affecting survival vary considerably over the Prairie-Plains.

Transplant losses are minor after the first season in the beds.

TABLE 10.—*Percent of trees over a given caliper class in 2–2 juniper and 2–2 ponderosa pine*[1]

Spacing (inches)	2–2 juniper with a caliper of at least—			2–2 ponderosa pine with a caliper of at least—		
	4/32 inch	8/32 inch	12/32 inch	4/32 inch	8/32 inch	12/32 inch
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
6 by 1....	97	30	1	92	41	3
6 by 1½..	99	33	3	99	59	10
6 by 2....	93	53	8	99	63	12
6 by 4....	99	70	18	97	59	14
12 by 1...	97	33	2	94	50	19
12 by 1½.	97	49	5	100	62	23
12 by 2...	100	54	9	97	69	21
12 by 4...	99	88	40	100	79	46
18 by 1...	98	48	13	87	44	9
18 by 1½.	98	71	21	99	63	12
18 by 2...	100	74	27	99	70	26
18 by 4...	100	83	44	100	83	50
24 by 1...	92	55	16	97	55	19
24 by 1½.	99	53	11	96	53	12
24 by 2...	98	58	13	99	74	31
24 by 4...	100	84	47	100	84	36

[1] Based on 100 trees of each species in each spacing, or a total of 1,600 trees per species.

TABLE 11.—*Average first-year losses in transplants at the Bessey Nursery, Halsey, Nebr., 1943–1956*

Species	Age class	Average loss
	Years	*Percent*
Juniper:		
Eastern redcedar	1–1	4.4
Do	2–1	12.5
Rocky Mountain	1–1	11.5
Do	2–1	15.2
Pines:		
Austrian	2–1	10.1
Jack	2–1	14.9
Ponderosa	1–1	12.4
Do	2–1	7.4
Red	2–1	11.1
Spruce:		
Blue	2–1	6.1
White	2–1	8.7
Do	3–1	11.4

SEASON OF TRANSPLANTING

Transplanting is invariably done in the spring in the Prairie-Plains. Fall transplanting has been tried, but its use generally resulted in abnormally high losses, especially in the Northern Plains.

Trees should be transplanted as early in the season as possible to take maximum advantage of the growing season, especially when the trees are left in the transplant bed only 1 year. In the Dakotas, some transplanting has been done in late May and early June and has been successful, especially in producing ponderosa pine and juniper stock that was rather well balanced as 2–2 stock. It could more accurately be described as 2–1½ stock since it had only about 1½ growing seasons in the transplant bed.

TOP AND ROOT PRUNING

Top and root pruning are used in Prairie-Plains nurseries to retard excessive top growth and keep the trees in better balance. Some favorable results have been obtained, but there is insufficient information on which to make general recommendations. Root pruning of seedlings and transplants is also done in the beds prior to lifting as a preparation for transplanting or packing.

The survival of blue spruce of 2–2 or 3–2 age class undercut in the third week of April in the transplanting bed was 18 percent greater (range 4 to 27 percent) than that of unpruned stock.[12] The first-year field survival of the undercut stands was 94 to 100 percent. Ponderosa pine of 2–2 age undercut in the same series of tests had a survival of 100 percent, while the unpruned stock had a survival of 94 percent.

Undercutting of third-year Rocky Mountain juniper in the spring at Towner Nursery in North Dakota slightly improved the balance. Fairly fibrous root systems resulted from a strong stimulation in lateral rooting. Practically no roots formed at the point of root pruning.

To cut nursery production costs, root pruning of seedling stock in place has been recommended as a substitute for transplanting in areas of better rainfall (Foster 1932, Hastings 1923), but it has not been tested very much in the drier Prairie-Plains area. A special thin-bladed root pruner (Olson 1930, Stoeckeler and Jones 1957) or a lifter with the kicker prongs removed is used. Seedbeds are sometimes root pruned with a horizontal V-shaped steel blade. Bed margins bordering paths have been vertically pruned with 18-inch rolling coulters in drill-sown seedbeds in early June (Clifford 1956a). Two weeks later the entire bed was undercut by horizontal pruning.

At the Towner Nursery in North Dakota, top pruning of 3–0 ponderosa pine in June, while the new growth was still in a succulent stage, had an adverse effect. The unpruned trees had a first-year field survival of 49.2 percent, whereas that of the top-pruned trees was only 34.5 percent. A liquid fertilizer was applied to the trees in this test within a week or so after

[12] Personal communication with E. J. George, Agricultural Research Service Field Station, Mandan, N. Dak., Mar. 2, 1958.

pruning, a procedure found desirable in later top and root pruning experiments in the Lake States (Stoeckeler and Jones 1957).

Junipers seem more amenable to top pruning than pines. Rather substantial improvement in balance was obtained by top pruning 2–2 Rocky Mountain juniper at the Towner Nursery (table 12). The reduction of excessive top length by top pruning may improve the balance of juniper. But more specific information on the effects on field survival is needed before top pruning can be generally recommended for 2–2 Rocky Mountain juniper.

If this species becomes too large at the 2–2 age, as it does in some nurseries in the Dakotas, an alternative may be to grow 2–1 stock, assuming it gives high field survivals.

TABLE 12.—*Effect of three degrees of top pruning on size and top-root weight ratio of 2–2 Rocky Mountain juniper*

Degree of top pruning	Average length of top just after pruning	Measurements of 2–2 stock in fall						Top-root ratio
		Length		Stem diameter	Fresh weight per tree			
		Top	Root		Top	Root	Total	
	Inches	*Inches*	*Inches*	*64ths inch*	*Grams*	*Grams*	*Grams*	
None		14.0	10.6	13.8	29.41	8.87	38.28	3.32
Light	8.26	11.3	10.4	12.7	22.53	8.38	30.91	2.69
Severe	4.06	6.0	10.9	14.3	17.19	8.25	25.44	2.08

HARDENING-OFF

The hardening-off process prepares conifer stock for survival through the winter. It results from gradual exposure to temperatures that are about 32° F. (Harvey 1930, Levitt 1956). Physiological changes that increase cell sap concentration and reduce the succulence of young foliage protect the plants against sudden drops in temperature in late fall and from unseasonably warm winds in February and March. Hardening-off is encouraged by the reduction of the water supply and the removal of shade.

The cutting off or reduction of the water supply begins in late August in the Dakotas and in late September in the Southern Plains. Watering should be kept moderately low for 4 to 6 weeks thereafter. Excessive dryness, however, should be avoided. Sandy soils should not be allowed to dry below about 2 or 3 percent of available moisture.

Exposure to high light intensity accentuates the color change in eastern redcedar; color change is generally regarded as a visual criterion of hardening and formation of anthocyanins (McDermott and Fletcher 1955). The removal of half-shades will accentuate and advance fall coloration (fig. 33).

Certain species and age classes, notably 1–0 ponderosa pine, 1–0 and 2–0 jack pine, 1–0 Scotch pine, 1–0 lodgepole pine, and 1–0 eastern redcedar, have a marked color change in the fall—from green to purple, violet, or bronze (Büsse 1930, Dengler 1944, Kalela 1937, Kienitz 1922, Langlet 1936, Stoeckeler and Rudolf 1956). The color change, part of the normal hardening-off process, occurs from late September to early November, depending on the nursery location. It is especially striking in pine nursery stock grown from seed of colder or more northern latitudes (Stoeckeler and Jones 1957) than that of stock grown from seed of warmer or more southern areas. In one

F–475107

FIGURE 33.—Half-shade is rolled up in early September and left in paths until late October to harden-off the stock. It is then replaced to give overwinter protection. Towner Nursery, Towner, N. Dak.

study the degree of color change in jack pine showed a statistically high correlation with latitude and average January temperature of the seed source (Stoeckeler and Rudolf 1956). The abnormal color disappears during the next growing season, with little apparent effect on the plant.

DIGGING, GRADING, PACKING, STORING, AND SHIPPING

When nursery stock is ready to be outplanted or sold, its value is a result of all the direct and indirect costs that have accrued during the time required to produce it. Therefore, the digging, grading, and packing of trees must be supervised closely to assure healthy, uninjured stock when it is fieldplanted. In addition, the rapid completion of these operations permits earlier shipments to planters and an earlier resumption of other seasonal nursery operations. Some storage of the packed stock is inevitable, and facilities must be provided.

DIGGING NURSERY STOCK

Nursery stock lifters are of two general types (fig. 34). One type can be applied to the entire width of the bed at one time. It may be used for seedbeds or transplants. The lifter blade for undercutting a bed may be mounted on a sled or attached directly to the tractor. A lifter mounted hydraulically to the tractor is readily transported from place to place. The second type of lifter is the U-shaped digger used for transplants in rows. It is usually mounted in pairs on a Unicarrier frame.

Several elaborate lifter designs have appeared in recent years. These include (1) the agitating lifter of the Savenac Nursery, designed to remove some of the soil from the roots (Sowash 1954), (2) the Lanquist seedling harvester, which includes an endless belt on the lifter onto which counted trees are dropped in bundles (Lanquist 1954a), (3) a hydraulically operated lifter mounted on the back of a crawler tractor (Cossitt 1937), and (4) a modified two-row potato digger devised by Clifford (1956b) for lifting 2–0, 3–0, and 2–2 stock.

At the Bessey Nursery, production of an eight-man crew is 250,000 seedlings in an 8-hour day; four men pull, one packs, two carry trees to the baler, and one works on the tractor lifter. A foreman directs the operation.[13]

A day or two before lifting, beds should be watered. Watering reduces root breakage and rapid drying of the undercut beds or rows. The bed-type of lifter is generally dug in at the end of the bed before the power is applied. The lifter is run at a depth of about 7 inches for stock to be transplanted and at about 9 inches for stock to be fieldplanted. As the seedlings or transplants are loosened by the digger, the labor crews pull the trees upward in bunches and shake the roots to remove surplus soil (fig. 35). Stock should be grasped well down around the stems and in small enough bunches to avoid injuring or stripping the needles and roots.

The importance of exposing roots of trees as little as possible has been repeatedly emphasized (Briggs 1939, Cummings 1942, Haasis 1914, Stoeckeler and Jones 1957, Toumey and Korstian 1942, Wakeley 1954). Conifers are particularly sensitive, and as little as 5 minutes' exposure of Jeffrey pine has reduced field survival by 10 percent, and 10 minutes' exposure by 15 percent. Every 10-minute period thereafter, field survival was reduced by about 10 percent. At

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FIGURE 34.—Two types of tree lifters: *A*, Details of the Bessey Nursery seedling digger revised from the Smith tree lifter and used for 4-foot-wide beds. *B*, a two-row lifter mounted on a Unicarrier chassis, used for transplants lined out in long rows. Note burlap wrapping to reduce skinning of trees.

[13] Personal communication with M. K. Meines, Nursery Superintendent, Bessey Nursery, Halsey, Nebr.

F–502094

FIGURE 35.—Lifting 1–1 ponderosa pine transplants with a Smith tree lifter, Bessey Nursery, Halsey, Nebr.

the end of 50 minutes of root exposure, field survival was only about 15 percent (U.S. Forest Serv. Calif. Forest Expt. Sta. 1954). The rate of air movement, temperature, and relative humidity are important factors in the rate of root drying and subsequent damage. Hence, trees should be placed in boxes covered with wet burlap as promptly as possible and immediately transported to the grading and packing shed or shelter, to cold storage, or to crews doing transplanting.

Undercut beds tend to dry out fast, and trees should not be undercut more than a few hours before pulling. Work should be planned so that a minimum of unpulled undercut beds are left overnight or over the weekend. A light watering of the unpulled undercut beds with the overhead system may be desirable. Watering must not be so heavy as to cause substantial settling and repacking of the soil, or the pulling will be harder and more roots may be stripped.

Tree digging should be done as early in the spring as possible, while the trees are still reasonably dormant. A study at the Bessey Nursery in 1939 on the effect of early versus late lifting of eastern redcedar on first-year survival showed the serious disadvantage of late lifting:

Date of lifting [1]	*Survival of all trees*	*Survival of thrifty trees*
	Percent	*Percent*
March 31	74	57
April 28	33	22

[1] All trees were fieldplanted on May 5. Bessey Nursery 1939 Ann. Rpt.

Stock for field shipment is root pruned to a length of about 8 inches, stock for transplanting to 5 to 6 inches. In some nurseries, root pruning is done just after lifting and before the trees are placed in carrying boxes or trays. In other nurseries, it is done just before packing or transplanting. Pruning is done with a circular saw, meat cleaver, modified cleaver (Mony 1941), or a one-blade shear-type pruner with a stationary base similar to a paper trimmer (fig. 36).

GRADING

Grading nursery stock increases field survival and growth. It is especially important that the stock planted meets the grade specifications in areas where tree establishment is difficult to obtain. All nursery stock requires some grading to remove undersized and defective trees. This is done at the time of transplanting and when stock suitable for fieldplanting is lifted for shipment. Culls at the time of transplanting run about 10 to 15 percent. Discarded are the obvious runts; root-stripped, split, or skinned seedings; and diseased or insect-infested trees. Topheavy and oversized trees are also undesirable. In the grading operation, species mixtures resulting from mixed lots of seed can be separated.

Grading to remove undersized and damaged trees has consistently resulted in better survival and growth in the field (DeJarnette 1938, Fowells 1953, Read 1955).

F–502401

FIGURE 36.—The Savenac root trimmer in operation.

As early as 1910, Bates (1910) planted three grades of 2–1 ponderosa pine on the Nebraska National Forest and found first-year survival in the field to be 86, 73, and 65 percent, respectively, for large, medium, and small grades of stock.

In 1935, fieldplanting of 2–0 ponderosa pine of two size classes, made in 18-inch furrows on Valentine sand at the Denbigh Field Station near Denbigh, N. Dak., resulted in greater survival and height growth for large-grade stock. Of the 6,132 trees planted, 969 were of the small grade, which consisted of the poorest of the nursery-run stock. After 10 years in the field with no cultivation, 21.6 percent of the large-grade trees and 2.3 percent of the small trees survived. Average total heights were 2.4 and 1.3 feet, respectively.

Fowells (1953) found 10 to 11 percent greater survival of large grades of ponderosa pine after 9 years in the field. Ninth-year tree heights also were 12 and 18 percent greater for large grades of seedlings and transplants, respectively.

Undersized trees are culled out largely on the basis of stem caliper, although top length is sometimes used as well as root length and development. A caliper gage (Aamodt 1941, Barton 1940) is useful for training personnel in estimating stem diameter. It may consist of a Y-shaped piece of brass calibrated in diameter, a notch of a specific diameter cut into a wood or metal gage, or two pieces of steel welding rod spaced far enough apart on another rod to provide a fixed gage.

At the Towner Nursery, cull percent in transplants has been about as follows: 2–2 Rocky Mountain juniper, 15; 2–2 ponderosa pine, 10; 2–2 white spruce, 10; and 2–2 blue spruce, 2. In Oklahoma nurseries, cull percent in 2–0 seedlings of pine and eastern redcedar intended for fieldplanting is about 10 to 15 percent.

During the grading of stock, it is desirable to reduce the length of time and severity of conditions under which tree roots are exposed. Hence, the trees are generally moved indoors promptly and sorted. Sorting can be done efficiently on an endless belt marked in squares upon which exactly 10 trees are laid (Robbins 1942). Culls are dropped into boxes or onto the floor. A vegetable spray mist keeps the roots moist while they are on the belt. At the end of the belt, other workers pick off groups of 5 bunches and tie the stock in bundles of 50 with an electric bundle tier. Using this system, 8,200 trees can be lifted, graded, and tied per man-day.

PACKING

Trees are wrapped in burlap or waterproof asphaltic paper prior to shipment. They may be packed in a baler or rolled tight on a table. Cardboard containers often are used for parcel post shipments. Some crates are used.

With the Savenac tree baler (Olson 1930), two wires are placed in notches across the open end baling box (34 by 17½ by 15 inches deep on 20-inch legs), and two slats (1 by 2 by 24 inches) are laid at right angles to the wires. A strip of waterproof paper (1½ by 6 feet long) is laid over the wires. Some nurseries use 24-inch-wide burlap. Next, packing material is placed in a layer about 1½ inches deep, and a layer of trees is laid down, with the roots overlapped and the tops out toward each end of the baler. A layer of moss is laid down, and the process is repeated. After the baler is about half full, some moss is stuffed between the waterproof paper and trees at the two vertical walls of the baler so that no roots are in contact with the paper.

When the bale is completed and no roots are exposed, the two ends of the paper are held up and given enough turns around a third slat to take up all the slack.

The ends of the wire (Signode straps are sometimes used) are inserted into a Girard wire-tying machine, and two ties are made rather tightly to give a firm, compact bundle that will retain its shape, keep the moss in place, and not fall apart in subsequent shipment. Properly packed bales are barrel shaped and are about 18 inches in diameter (fig. 37).

The weight of the bundles and the number of trees each contains vary by species and age class and the packing material used. Weights and trees per bale of some species and age classes for the Bessey Nursery are listed below.

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FIGURE 37.—Two types of containers for shipping nursery stock: *A*, A packed bale being secured with a strapping machine as it lies in the tree baler, Bessey Nursery, Halsey, Nebr.; *B*, crates of the type used on the shelterbelt project, Towner Nursery, Towner, N. Dak.

Species	*Age class*	*Weight per bale* (*Pounds*)	*Trees per bale* (*Number*)
Austrian pine	2–2	83	800
Blue spruce	2–1–1	60	2,000
Eastern redcedar	2–2	85	645
Do	1–2	63	500
Do	1–0	60	10,250
Ponderosa pine	2–2	88	650
Do	1–2	98	2,000
Do	2–0	71	4,160
Rocky Mountain juniper	1–2	77	1,000

In table wrapping, which is better for small orders, a sheet of waterproof asphaltic paper, about 30 inches wide and 4 to 8 feet long (depending on bundle size), is laid on the table. A 1-inch layer of packing material, about 18 inches wide and 24 inches long, is put on one-half of the sheet near its end, and counted bundles of trees are placed on the paper, with all roots overlapped toward the center. Successive layers of moss and trees are built up until the bundle is full enough to wrap. A layer of moss completely covers all trees, and the bundle is rolled as tightly as possible and tied with binder twine or stout cord in three places.

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In another table wrapping method, all the roots are placed in one direction on the paper, with the layer of packing material toward one long edge of the paper. When rolled, the paper is folded over to enclose the bottom of the bundle, and tied twice around the circumference and once under the bottom.

Some cardboard boxes are used in parcel post and express shipments of bare-rooted conifers and potted grafts. The cardboard box shipments via parcel post are rather expensive, but the time in transit is minimized.

For Clarke-McNary shipments of stock by the State Forester in Nebraska, six standard box sizes are used:

Box number	*Dimensions in inches*
1A	4 by 4 by 30.
2	6 by 6 by 30.
3A	4 by 6 by 30.
4	6 by 10 by 30.
5	12 by 12 by 36.
6	10 by 10 by 30.

After assembly with 3-inch gummed paper, the boxes are lined with wax-coated freezer paper, which comes in rolls 18, 20, and 24 inches wide. The trees are

packed with well-squeezed sphagnum moss. When trees are packed with 25 to the bundle, the roots usually are overlapped in the center of the box and the tops are out. The packages are then sealed and addressed, and 12 holes are punched in the ends of the long sides near the tops of the trees for ventilation. Postage, affixed at the nursery, generally costs about $0.40 per 100 trees, $0.80 per 200 trees, and $2.00 per 1,000 trees. The largest boxes can hold about 1,000 trees each of 2–0 eastern redcedar or 2–1 pines, or 400 to 500 trees of 1–2 eastern redcedar.

A few nurseries pack trees in light crates of wood slats or veneer. Crates are most likely to be useful if trucks haul the trees from the nursery directly to the tree-planting site and bring the empty crates back to the nursery daily or several times a week. In such instances, the trees need not be counted or tied in bundles; a bed inventory or a general knowledge of the average number of trees per crate is a sufficient basis on which to determine the approximately correct number of trees that should be supplied to field crews or fieldplanting machines.

Some commercial nurserymen are using plastic film bags and a small amount of moist moss or peat around the roots of bare-rooted conifers up to about 2 feet tall. The method has considerable merit, especially in retail yards where stock may be held for considerable periods.

The packing materials used for conifers usually are a 50–50 mixture by volume of sphagnum moss and cedar shingle tow (shavings). The material comes dry in bales from the supplier and must be mixed and soaked down before use. Some nurseries keep a vat of prewetted material in a cool, shaded place; it is used to supply 50-gallon drums alongside the baler or packing table.

The water in the drums should be cold and should be cooled with ice if necessary. Warm packing materials accelerate heating and molding of baled or crated stock (Stoeckeler and Jones 1957). Usually the water from deep wells (about 45° to 52° F.) will not require precooling. In some nurseries concrete moss tanks and slatted drainboards are fitted across the top of the tank.

Excess water must be squeezed out of the packing material before use, in order to prevent excessive weight and soggy bundles. It is particularly detrimental in parcel post shipments made in cardboard boxes.

A detailed study of various packing materials by Mullins (1956), in which stock was stored up to 4½ weeks, showed that there was little to choose between four materials, based on subsequent field survival. The materials were commercial sphagnum moss, freshly collected local sphagnum moss, poplar excelsior (wood wool), and poplar excelsior treated with a wetting agent.

STORING AND SHIPPING

The interval between lifting and planting should be minimized. For example, a prolonged period in transit and storage between lifting and planting is a primary cause of poor field survival in shelterbelts.

However, a delay after the trees are lifted from the nursery bed is not always avoidable. Normal irregularity in planting operations due to weather or other factors is almost certain to disrupt the flow of stock. Lifting often must be done before the frost is out of the ground at the planting site. A more serious problem occurs when the nursery is located far north of the planting site and lifting cannot begin until some time after planting is feasible. In some situations storage of planting stock may be necessary for a few days to several months.

The length of time permissible for storage depends on temperature, moisture conditions, packing material, species, and growing conditions subsequent to planting. Trees can be stored by three general methods: Heel-in storage, indoor storage at room temperature, and cold storage. Great care must be taken to prevent heating, molding, drying, high transpiration, hard-freezing, and damage by rodents and insects.

Stock in bales, crates, or cardboard containers may be stored indoors in a ventilated shelter for a few days (fig. 38). In cool weather, such storage is permissible for about a week. In warmer weather, when indoor temperatures in the storage shelter reach 70° F. or above, the trees can be stored in this way for only a day or two because heating and molding may occur.

Test plantings of 2–0 eastern redcedar in central and western Oklahoma, conducted to determine the effect of storage and season of planting on survival, showed that storage for an extra week in the packages in which they had arrived from the nursery had little, if any, effect on survival (Afanasiev et al. 1959). Plantings were made at four sites at weekly intervals from mid-November to May during three planting seasons.

Unbaled conifers have also been stored successfully indoors for several days to a week on a slat platform 6 to 8 inches above the floor (Engstrom 1941). One- or two-inch-mesh chicken wire is formed into a cylinder 18 inches in diameter and 4 feet high. A 3-inch layer of moist moss or other packing material is laid down, and the trees are placed on top of it, with the tops out and with the root ends just touching the wire. Alternate layers of moss and trees are built up to the height of the wire form. In warm weather a block of ice may be dropped on top of a 3-inch-deep layer of moss inside the chicken wire, and a board or other cover may be placed on top.

A modification of this system consists of platforms or racks 24 inches wide, with uprights at each end. Layers of trees are placed with tops out and roots overlapped; enough moss is used to keep the roots moist. Chipped or chunked ice can be placed on top to provide a cooling effect in warm weather.

At the Northern Great Plains Field Station of the Agricultural Research Service, at Mandan, N. Dak., stock is usually stored on the floor of a root cellar;

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FIGURE 38.—Stacked bales of 2–1 ponderosa pine in storage and ready for shipment by truck, Bessey Nursery, Halsey, Nebr.

individual tree bundles (not bales) are stacked upright in a single layer. Any larger air spaces below the tops are filled with moist packing material. With this method, survivals are reported to be 20 to 25 percent higher than they are with conventionally stacked horizontal storage.[14]

For periods longer than a week, cold storage is necessary. Many nurseries use mechanically refrigerated or ice-cooled cold-storage buildings. A temperature of 33° to 40° F. is preferred. At this range, respiration and transpiration are minimized, and heating and molding are prevented. A temperature of 50° is reasonably satisfactory. The humidity is maintained at about 90 to 95 percent. An average size cold-storage plant has a capacity of around 5,000 cubic feet and can hold 600,000 to 700,000 1–0 or 2–0 trees.

In the Dakotas, stock is often stored on natural ice in the spring. Partitioned-off areas in storage sheds are prepared by flooding and freezing during the winter. The stock is stored in mulch laid on the 4- to 6-inch layer of ice.

Stock has been held in cold storage for long periods with little or no drop in field survival (Brown 1937, Deffenbacher and Wright 1954, Fowells and Schubert 1953, Pike 1933, Sowash 1936).

Heel-in storage should be regarded as a last resort for conifers and should be limited to the spring season. The storage period should not be more than a week or two; the shorter the time the better. The trees should be shaded, but a ventilated space of at least 1 foot above the trees should be provided if canvas or similar material is used.

In heel-in storage, a straight, broad V-shaped trench is dug to a depth of 8 to 12 inches, and the well-moistened soil is piled in a ridge at the back. Friable sandy to silt loam material is preferred. A thin layer of trees with not more than 1 inch of root-layer thickness is laid down, and a 2-inch layer of soil is immediately spaded out and placed on top of the roots. The soil

[14] Personal communication with E. J. George, Northern Great Plains Field Station, Agricultural Research Service, Mandan, N. Dak.

F–345374

FIGURE 39.—Heeling-in 1–0 ponderosa pine, Plumfield Nursery, Fremont, Nebr.

is firmed gently with the bottom of the foot (fig. 39). Successive layers of trees and soil are added until all the trees are heeled-in.

The soil must come well above the root collar, but it should not cover the needles. The layers should be of uniform depth. A light sprinkling may be done as heeling-in proceeds or shortly thereafter. Some nurserymen dip the roots of each bundle or handful of stock in water before heeling-in.

In shipment, larger quantities of planting stock usually are transported in 1½-ton trucks or larger units such as truck trailers. A 1½-ton truck can haul about 60,000 2–2, 90,000 3–0, or 180,000 2–0 trees if they are crated, and about 50 percent more of each class of stock if it is packed in bales. Pickup trucks are frequently used to transport smaller quantities of stock for shorter distances.

State nurseries usually rely on railway express shipments or motor freight for serving customers.

For the usual nonrefrigerated truck shipments, the chief precaution is a check for temporary load limits that may have been imposed along the route to be traveled during or following spring breakup. The cargo should be well protected against the sun and wind with tarpaulins. In warm weather, it may be possible to do most of the trucking at night. Watering enroute should not be necessary if loads of trees are properly packed and protected against wind and sun. When the destination is reached, the stock should be unloaded immediately in a building, under the shade of trees, or in a field icehouse constructed for stock storage.

POTTING AND BALLING NURSERY STOCK

Conifer nursery stock is potted or balled to increase field survival on nonirrigated lands in the drier portions of the Prairie-Plains. Potted stock is used in field-planting, whereas the more expensive balled stock is used most often in ornamental planting.

Ponderosa pine has rather poor root-producing ability (Stone 1955) and rather poor field survival when planted as bare-rooted stock in a zone from approximately the 101st meridian westward to the Rocky Mountain area. This zone includes areas in North Dakota with less than 16 inches of annual rainfall; areas in Nebraska with 19 inches or less; and areas in western Oklahoma and northwest Texas with 22 inches or less. This is a zone of high drought frequency (Bates 1935). In farm plantings under these conditions, consistently satisfactory conifer survival may be obtained only with potted stock. Potted trees are also used frequently to replace losses in plantings made originally with bare-rooted trees. The potting is usually done a full growing season before field-planting.

Potted stock has several advantages that favor high survival. Practically all the feeder roots are still intact when planted, whereas unpotted stock often loses some of these feeder roots when it is lifted. The root system of potted stock is more compact, has an optimum bond with the soil, and can continue uninterrupted extraction of moisture at the planting site; bare-rooted plants must re-establish this bond by extension of the root system. The reserve supply of moisture within the pot is adequate to enable the potted stock to withstand several weeks of drought, while the bare-rooted plant is immediately and totally dependent on whatever moisture it is able to extract from the planting site. The soil in the pot can be ideally proportioned to stimulate root development and can include substantial amounts of organic matter to increase the water-holding capacity. The roots or tops of potted stock are much less likely to heat or mold in transit than those of bare-rooted stock.

The principal disadvantage of potted trees is the higher unit cost. Some reasons for this increased cost are the materials and labor expended in the potting operation, the need for lathhouses or special structures

to protect the potted trees during growth and storage, and the increased transportation costs for distribution to the planting site.

In western Oklahoma, potted eastern redcedar planted during 2 years of low precipitation had an average survival of 96 percent, compared to 70 percent for bare-rooted stock planted on the same site (Afanasiev et al. 1959). However, the following year both classes of stock had 94 percent survival.

In tests conducted by the Manhattan Nursery between 1949 and 1953, use of potted stock increased survival of juniper 15 to 20 percent and that of pine 30 to 40 percent.[15]

At the Northern Great Plains Field Station of ARS, initial survivals of 90 to 100 percent were obtained with potted ponderosa pine.[16]

In western Kansas, the pines and cedars are generally potted at the 2–0 age in April in 1½- by 2½- by 6-inch pots and held 1 year before shipment for shelterbelt planting. The 1–0 eastern redcedar sometimes is large enough to pot and hold for sale as 1–1.

Since bare-rooted Arizona cypress transplants poorly, potted stock is fieldplanted almost exclusively in the Southern Great Plains and the Southwest. It may be seeded under glass in November in flats of ground-up sphagnum moss, or in sterilized loamy sand soil. The seedlings are lifted in March when they are about 3 inches tall, and potted in asphaltic bands or in 2½-inch clay pots. Some of the potted seedlings are ready for fieldplanting the following spring; others are repotted in 1-gallon cans and left for another year.

Potted 16-month-old Arizona cypress ready for fieldplanting will be about 8 inches tall; 1–1 Austrian pine, 4 inches tall; 2–1 Austrian pine, 10 inches tall; 1–1 eastern redcedar, 10 inches tall; and 2–1 eastern redcedar, about 22 inches tall.

Asphaltic roofing paper is one of the materials used for pots. The method developed by Johnson (Johnson 1955, Johnson and Vanderslice 1956) illustrates its use. The 36-inch-wide rolls are cut lengthwise into three 1-foot-wide sections; then each section is cut into 12- by 12-inch sheets. The paper is given four creases to form a finished pot 2¾ by 2¾ by 10¾ inches and stapled at the edges five or six times. The bottom 1½ inches is creased.

A somewhat similar pot of 15-pound roofing felt was devised by Morris of the Soil Conservation Service and described by Downs (1954).

Manufacturers produce inexpensive, flat-packed, 15-pound asphalt-band pots with both ends open. Their sizes range from 2 by 2 by 6 inches to 3 by 3 by 6 inches. The 2½- by 2½- by 6-inch band contains enough soil for a 1- or 2-year-old pine or juniper seedling to grow an additional year and still feed through the standard fieldplanting machines. Such trees occasionally have been held a second year, but the pots tend to deteriorate and fall apart. A 30-pound paper has been better for trees carried in pots 2 years.

The use of growth promoters such as indoleacetic acid or vitamin B has resulted in root response on southern pines (Plank 1939). Fowells (1943), however, found no appreciable response in the number of secondary roots in ponderosa pine when similar treatments were applied just before the trees were placed in tar paper pots; however, the length of the root system was improved slightly.

Shaw (1963) describes a potting system developed by the Colorado State Forest Service. In this mechanized operation, a series of live conveyor belts is used to move the potting trays from step to step, and a soil packing machine is operated by hydraulic pressure. Other recently developed devices include a hexagonal soil pot equivalent to a standard 3-inch clay pot and a potting machine capable of forming 750 pots per man-hour; the range in the diameters of the pots is 1.6 to 3.2 inches (Food and Agriculture Organization 1954).

The 2½- by 2½- by 6-inch pots can be filled with soil, and about 750 to 1,000 plants per man-day can be set in. Tomato lugs (flats) that will hold 30 asphalt bands are used. A spacer is necessary to keep the pots open and lined up properly. They are tamped by jarring the whole flat. The bottom few inches of soil are tightly packed with a 2- by 2-inch tamper before the seedlings are placed in the pot and the pot is filled. The tamped plug keeps the soil from sliding out of the bottom of the pots while they are being transferred to a bed in a lathhouse. The pots when planted weigh about 2 pounds apiece.

Larger, heavy asphalt pots 6 inches in diameter and 7 inches deep can also be purchased on the open market, as can the 1-, 2-, or 4-gallon metal cans. The tapered 1-gallon metal pots have distinct advantages over vertical-walled 1-gallon fruit cans because the plant and its ball of soil can be more quickly and easily removed from them for planting; they are extensively used in commercial nurseries.

Tapered-steel cylinders have been used for a number of years at the Agricultural Research Station at Woodward, Okla.,[17] to lift trees for balling (fig. 40). The cylinders are 17½ inches long, are of 18-gage metal, and are about one-fourth to one-half inch smaller in diameter at the bottom than at the top. The following diameters are in use: 6, 8, 10, 16, 18, and 24 inches. When used, the cylinders are forced full depth into the soil around the trees. The tree and cylinder are then lifted. A clamp is released, the cylinder is lifted off the soil, and the ball of soil is wrapped in burlap.

The general idea of cylinder balling was adapted to a commercially manufactured, power-operated balling

[15] Personal communication with A. E. Ferber, Soil Conservation Service, Denver, Colo.

[16] Personal communication with E. J. George, Northern Great Plains Field Station, Agricultural Research Service, Mandan, N. Dak.

[17] Personal communication with E. W. Johnson, Southern Plains Field Station, Agricultural Research Service, Woodward, Okla.

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FIGURE 40.—Transplanting cylinders with 6-, 8-, 10-, and 16-inch top diameters used to expedite balling of conifers in sandy soils, Woodward, Okla.

machine. It functions well if soils are medium-textured, free of stones, and have a good soil moisture content, and if many trees of uniform size can be dug without frequent change of cylinder size. Balling and burlapping has been a standard method for handling larger ornamental stock in the commercial nursery industry for many years (fig. 41).

In recent years, heavy paper, plastic, metal, or other types of containers, about 8 to 20 inches in diameter, have found favor in the handling and shipping of evergreens in the 2- to 5-foot height class.

The potting mixture used in Prairie-Plains commercial nurseries in the 1-gallon or larger containers is generally about two parts of fertile topsoil, one part peat moss, and one part sand. In some nurseries one-fifth pound of high-analysis commercial fertilizer, such as ammonium phosphate, per cubic yard, is added. In other nurseries 1 pound of Milorganite per wheelbarrow of mix is used. In potting Arizona cypress and pines with top soil that has some alkalinity (pH 7.5 to 7.7), some Southern Plains nurserymen use several pounds of "sulfa soil" per cubic yard to reduce the pH and make phosphates and iron more available. All material is run through a shredder.

In areas where good topsoil is becoming increasingly more expensive, some nurseries use a 75–25 mixture of moderately acid fine sand and peat; each cubic yard is fortified with 6 ounces of potassium nitrate, 4 ounces of potassium sulphate, 2½ pounds of ordinary superphosphate, 4½ pounds of dolomitic limestone, 1¼ pounds of calcium carbonate lime, and 1¼ pounds of gypsum (Matkin and Chandler 1957, Baker et al. 1957). In a supplemental treatment, liquid feeding with nitrogen fertilizers is used; 1 pound of 33 percent ammonium nitrate per 100 gallons of water (Matkin and Chandler 1957) or a complete N-P-K (nitrogen, phosphorus, potash) fertilizer is applied.

Details have been published on potting-soil mixtures and their basic ingredients, fortification with dry fertilizers, use of additional liquid fertilizers, disease control, and efficient mechanization of all aspects of the growing of plants in containers (Baker et al. 1957).

F–475115

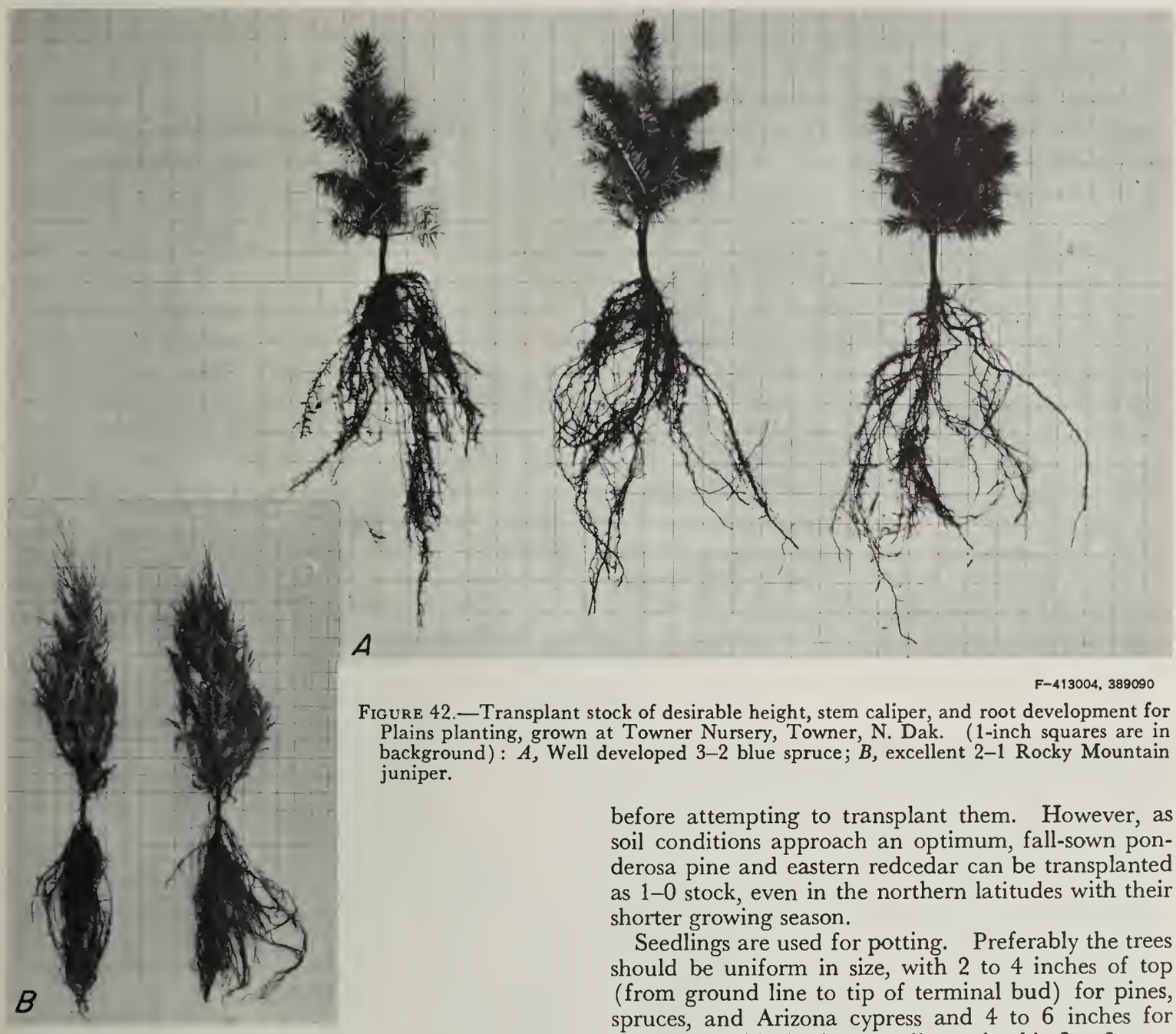
FIGURE 41.—Balling and burlapping blue spruce, Esmond, N. Dak.

AGE CLASSES OF STOCK NEEDED FOR THE PLAINS

Both transplants and seedlings are produced for planting in the Plains. In the North transplants are used almost exclusively, while in the South seedlings as well as transplants are used. Good-quality stock is required. Such stock has a large amount of fibrous root system and a top about 6 to 12 inches from the ground line to the tip of the terminal bud (or tip of cedars) (fig. 42). It should have a thick, sturdy stem that will hold the plant erect despite wind, clods thrown against it in cultivation, or the matting-down action of snow, weeds, or grass.

The age class to which a tree species should be grown to attain a proper root system, stem caliper, and height largely depends on the length of the growing season and the tree species. The level of soil fertility is another important factor.

The usual age classes of stock by species used in field-planting and nursery transplanting under Prairie-Plains conditions are given in table 13. Species selection is largely dictated by past performance in survival, growth, ease of establishment, and relative freedom from serious pests. State extension foresters, research



F-413004, 389090

FIGURE 42.—Transplant stock of desirable height, stem caliper, and root development for Plains planting, grown at Towner Nursery, Towner, N. Dak. (1-inch squares are in background): *A*, Well developed 3–2 blue spruce; *B*, excellent 2–1 Rocky Mountain juniper.

foresters, horticulturists, and others have prepared numerous guides and observations on tree species adaptable to the Plains. Current summaries include those of George (1953, 1957) and Read (1958).

Stock suitable for transplanting in the nursery is 1 to 3 years of age. In the Dakotas, spruces and firs are grown to a 2–0 or 3–0 age; junipers, redcedars, jack pine, and Scotch pine to a 2–0 age; and ponderosa pine to a 2–0 or occasionally 1–0 age before transplanting. From Nebraska south to Texas, eastern redcedar is usually transplanted as 1–0 stock, and Rocky Mountain juniper as 1–0 or 2–0. Ponderosa pine is transplanted as 2–0 or 1–0; the former age is more prevalent in Nebraska.

The influence of increasing age class and the benefits of transplanting are illustrated in figure 43.

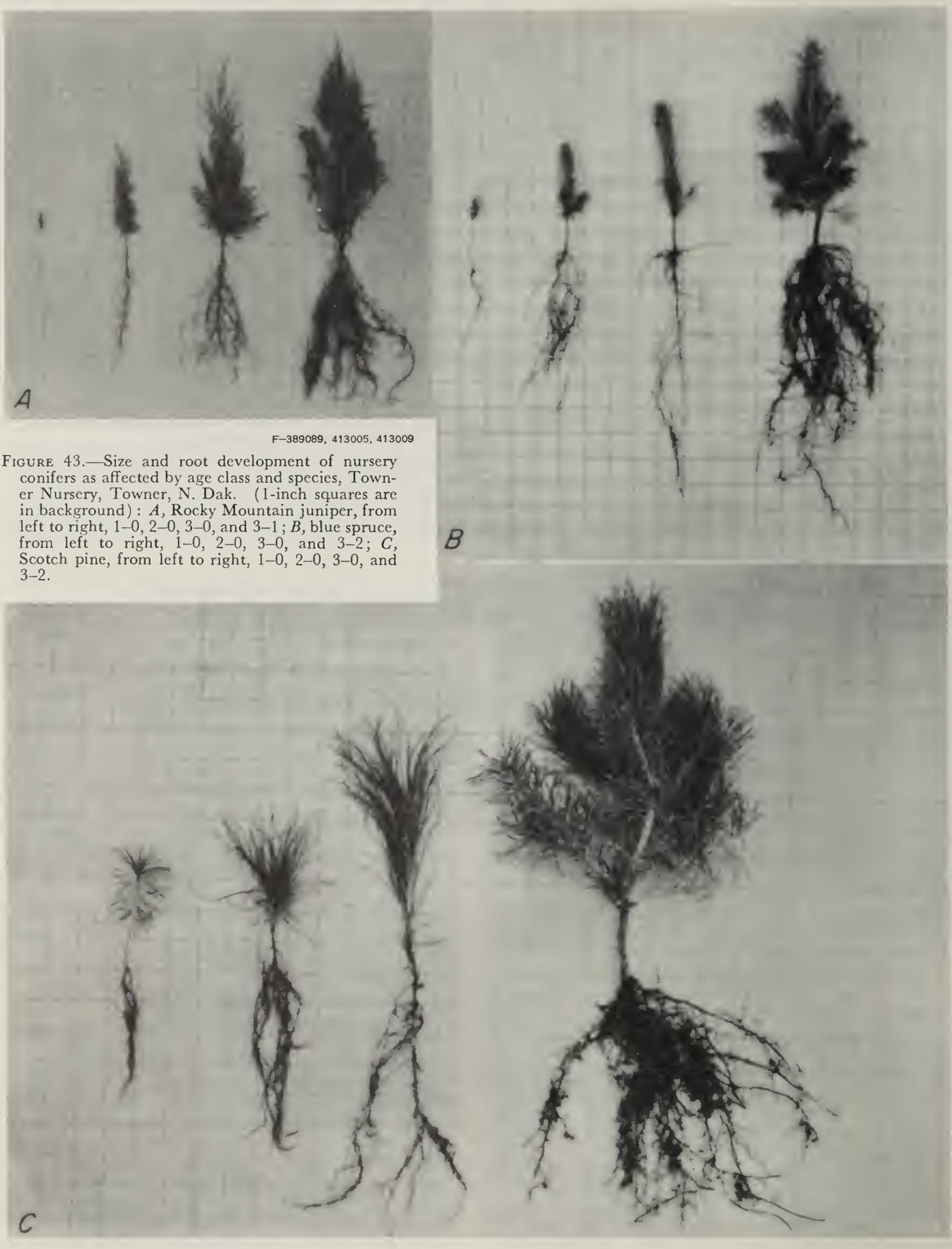
In northern nurseries it is generally better to grow the conifers, including ponderosa pine, to the 2–0 age before attempting to transplant them. However, as soil conditions approach an optimum, fall-sown ponderosa pine and eastern redcedar can be transplanted as 1–0 stock, even in the northern latitudes with their shorter growing season.

Seedlings are used for potting. Preferably the trees should be uniform in size, with 2 to 4 inches of top (from ground line to tip of terminal bud) for pines, spruces, and Arizona cypress and 4 to 6 inches for junipers. This size is generally attained in 2 or 3 years by spruces, in 2 years by pines, in 1 year by juniper in the Southern Plains and in 2 years in the Central or Northern Plains, and in 3 months by Arizona cypress.

The dimensions of typical species and of a number of age classes vary among nurseries in the Northern, Central, and Southern Great Plains (tables 14 to 16). Generally the size of comparable age classes of the same species increases from north to south.

Well-balanced trees have a rather high proportion of their total weight in roots. Such plants have a better chance of survival under the high transpiration stress of difficult dry planting sites. The top-root ratio of good transplants generally ranges from 2.0 : 1 to 3.5 : 1.

In contrast, 2–0 or 3–0 seedlings of somewhat comparable top length have a top-root ratio of 4.0 : 1 to 6.0 : 1. Moreover, in the seedling stock, a higher proportion of the weight of top is in the needles (a reflection of the size of the transpiration mechanism).



F–389089, 413005, 413009

FIGURE 43.—Size and root development of nursery conifers as affected by age class and species, Towner Nursery, Towner, N. Dak. (1-inch squares are in background): *A*, Rocky Mountain juniper, from left to right, 1–0, 2–0, 3–0, and 3–1; *B*, blue spruce, from left to right, 1–0, 2–0, 3–0, and 3–2; *C*, Scotch pine, from left to right, 1–0, 2–0, 3–0, and 3–2.

TABLE 13.—*Age classes and species of conifers commonly used and being tested in the Prairie-Plains of the Midwestern United States and nearby Canada*

Species [1]	Age class	Areas where grown
Arborvitae, Oriental	1–0	Okla., Tex.
	2–0	Do.
Cypress, Arizona	1–0	Okla.,[2] Tex.
Douglas-fir [2]	2–2	Canadian Plains, N. Dak., S. Dak.
Fir:		
Balsam [2]	2–2	Canadian Plains
Siberian [2]	2–2	Do.
Juniper:		
Common [2]	2–1	N. Dak., S. Dak., Nebr.
Ashe	2–0	Okla.,[2] Tex.
	1–1	Okla., Tex.
One-seed	2–0	Kans.,[2] Okla.,[2] Tex.
	1–1	Kans., Okla., Tex.[2]
Rocky Mountain	2–0	Canadian Plains, Okla., Tex.
	1–1	Okla., Tex.
	2–1	Canadian Plains,[2] N. Dak., S. Dak.
	1–2	Kans., Nebr.
	2–2	N. Dak., S. Dak.
Larch:		
European	2–1	Canadian Plains
	2–2	Do.[2]
Siberian	2–1	Canadian Plains, N. Dak.
	2–2	Canadian Plains,[2] N. Dak.[2]
Pine:		
Austrian	2–0	Okla., Tex.
	1–1	Okla.,[2] Tex.[2]
	2–1	S. Dak., Nebr., Kans.
	2–2	S. Dak., Nebr.
Digger [2]	1–0	Okla.
	1–1	Do.
Italian stone [2]	2–0	Do.
	1–1	Do.
Jack	1–1	Nebr.
	2–1	Canadian Plains, N. Dak., S. Dak., Nebr.
Pine—Continued		
Japanese black	2–0	Okla.
	1–1	Do.[2]
Japanese red	2–0	Do.
	1–1	Do.[2]
Limber [2]	2–1	Okla., Tex.
	2–2	N. Dak., S. Dak., Nebr., Kans.
Loblolly [2]	1–0	Okla.
Lodgepole	2–1	Canadian Plains [2]
	2–2	Do.
Pinyon [2]	2–0	Kans., Okla., Tex.
	1–1	Do.
Ponderosa	2–0	Okla., Tex.
	1–1	Do.
Ponderosa	1–2	N. Dak., S. Dak., Nebr., Kans.
	2–2	Canadian Plains, N. Dak., S. Dak.
Scotch	2–1	Do.
	1–2	S. Dak., Nebr., Kans.
	2–2	Canadian Plains, N. Dak.
Shortleaf	1–0	Okla., Tex.
Swiss stone [2]	2–2	Canadian Plains, N. Dak., S. Dak.
Redcedar, Eastern	2–0	N. Dak., Nebr., Okla., Tex.
	1–1	Nebr., Kans., Okla., Tex.
	1–2	Nebr., Kans.
	2–1	N. Dak., S. Dak.
	2–2	S. Dak.
Spruce:		
Blue	2–2	Canadian Plains, N. Dak., S. Dak., Nebr., Kans.[2]
	2–3	Canadian Plains, N. Dak.
	3–2	Do.
Siberian [2]	2–2	Do.
White	2–2	Canadian Plains, N. Dak., S. Dak., Nebr.
Tamarack [2]	2–1	N. Dak.

[1] See Appendix for scientific names.
[2] Not used extensively, still being tested, or receiving restricted use in areas of better rainfall.

TABLE 14.—*Measurements of various age classes of Towner Nursery stock, Towner, N. Dak., fall 1941 and spring 1958*

Age class	Species	Trees per square foot		Trees measured	Length		Stem diameter	Fresh weight per plant	Top-root ratio based on green weight
		Seedbed	Transplant bed		Top	Root			
		Number	*Number*	*Number*	*Inches*	*Inches*	*64ths inch*	*Grams*	
1–0	Eastern redcedar	30		15	2.9	7.2	3	1	2.6
2–0	do	40		10	6.8	8.2	9	13	2.8
1–1	do	40	16	10	5.4	9.8	8	10	1.8
1–0	Rocky Mountain juniper	20		10	2.9	6.5	3	1	2.3
2–0	do	30		15	5.2	8.9	5	3	2.0

TABLE 14.—*Measurements of various age classes of Towner Nursery stock, Towner, N. Dak., fall 1941 and spring 1958*—(Continued)

Age class	Species	Trees per square foot		Trees measured	Length		Stem diameter	Fresh weight per plant	Top-root ratio based on green weight
		Seedbed	Transplant bed		Top	Root			
		Number	*Number*	*Number*	*Inches*	*Inches*	*64ths in.*	*Grams*	
[1] 3–0	Rocky Mountain juniper (Cont.)	5	.....	10	15.9	11.6	25	87	4.2
2–1	.....do.....	30	16	10	7.5	8.3	7	7	2.0
[2] 2–2	.....do.....	50	16	15	14.0	10.6	14	38	3.3
[3] 2–2	.....do.....	50	16	10	11.3	10.4	13	31	3.7
[4] 2–2	.....do.....	50	16	10	6.0	10.9	14	25	2.1
1–0	Ponderosa pine.....	40	.....	15	1.6	7.6	4	1	1.4
2–0	.....do.....	.....	.....	20	2.7	8.5	6	3	1.5
[2] 3–0	.....do.....	26	.....	10	6.2	8.6	15	20	6.1
[5] 3–0	.....do.....	13	.....	14	4.4	9.7	14	16	4.7
1–1	.....do.....	40	16	10	3.1	8.3	10	9	2.2
2–1	.....do.....	([6])	([6])	20	4.6	13.3	15	23	3.7
2–2	.....do.....	40	16	15	7.6	14.0	21	58	3.4
1–0	Scotch pine.....	30	.....	10	1.6	4.2	2	([7])	1.1
2–0	.....do.....	30	.....	10	2.4	7.8	8	4	2.5
[8] 3–0	.....do.....	30	.....	15	5.0	8.8	9	5	3.6
[9] 3–0	.....do.....	30	.....	15	2.5	7.5	6	3	3.2
2–2	.....do.....	40	16	15	7.8	11.2	17	32	2.6
1–0	Blue spruce.....	18	.....	10	0.7	5.5	2	([7])	1.3
2–0	.....do.....	([6])	.....	20	2.7	7.9	4	2	2.2
3–0	.....do.....	73	.....	15	4.9	8.2	7	4	2.3
2–1	.....do.....	([6])	.....	20	4.4	11.4	10	5	1.2
2–2	.....do.....	([6])	.....	20	6.8	18.2	17	26	1.9
3–2	.....do.....	75	16	15	6.3	9.2	13	22	2.3
2–0	Jack pine.....	20	.....	15	3.6	9.5	8	7	3.2

[1] Low seedbed density. [2] Not top pruned. [3] Top pruned at 8 inches. [4] Top pruned at 4 inches. [5] Top pruned at 4 to 5 inches [6] Data not available. [7] Less than 1 gram. [8] Mycorrhizal soil. [9] Nonmycorrhizal soil.

TABLE 15.—*Measurements of various age classes of Bessey Nursery stock, Halsey, Nebr., spring 1958*

Age class	Species	Trees per square foot		Length [1]		Stem diameter [1]	Fresh weight per plant [1]	Top-root ratio based on green weight
		Seedbed	Transplant bed	Top	Root			
		Number	*Number*	*Inches*	*Inches*	*64ths inch*	*Grams*	
2–0	Eastern redcedar.....	50	.....	9.2	14.9	16	38	2.5
1–1	.....do.....	([2])	17	5.6	11.7	7	9	1.5
1–2	.....do.....	([2])	17	12.6	18.9	14	26	2.1
1–0	Rocky Mountain juniper.....	60	.....	2.3	5.5	2	1	2.3
1–2	.....do.....	([2])	17	8.0	13.6	13	18	2.5
1–0	Ponderosa pine.....	50	.....	1.4	6.6	4	2	1.7
2–0	.....do.....	50	.....	4.0	12.0	14	17	1.6
1–1	.....do.....	([2])	17	3.3	12.5	12	8	2.0
1–2	.....do.....	([2])	17	5.5	15.6	18	27	3.0
2–1	.....do.....	([2])	17	2.9	11.0	12	8	1.6
2–2	.....do.....	([2])	17	13.4	22.0	32	109	4.1
1–0	Austrian pine.....	50	.....	1.2	7.3	3	1	1.7
2–0	.....do.....	50	.....	2.7	11.0	6	4	1.6
2–1	.....do.....	([2])	17	4.3	14.2	12	15	1.5
2–2	.....do.....	([2])	17	12.2	26.2	21	75	2.8
2–0	Red pine.....	60	.....	1.4	11.6	7	6	.6
2–1	.....do.....	([2])	17	4.4	12.5	12	12	1.2
1–0	White spruce.....	75	.....	.5	2.6	1	([3])	2.0
1–0	Blue spruce.....	75	.....	.7	3.6	1	([3])	.5
2–1	.....do.....	([2])	17	3.1	10.1	6	5	.8
2–1–1	.....do.....	([2])	17	4.5	9.5	7	9	1.2

[1] Twenty trees were measured for each combination of species and age class except blue spruce 2–1–1, for which only 16 trees were measured.

[2] Data not available.

[3] Weights less than 1 gram.

TABLE 16.—*Measurements of various age classes of Norman Nursery stock, Norman, Okla., spring 1958*

Age class	Species	Trees per square foot of seedbed	Length [1]		Stem diameter [1]	Fresh weight per plant [1]	Top-root ratio based on green weight
			Top	Root			
		Number	*Inches*	*Inches*	*64ths inch*	*Grams*	
1–0	Eastern redcedar	40	5.4	10.3	6	5	3.6
2–0	.....do	40	17.0	15.8	19	48	3.6
1–0	Ponderosa pine	30	2.4	8.9	6	2	2.3
2–0	.....do	30	6.6	13.0	16	21	3.4
3–0	.....do	30	12.2	17.0	24	47	4.2
1–0	Austrian pine	35	1.9	7.6	3	2	3.4
2–0	.....do	35	5.3	12.2	12	14	2.8
3–0	.....do	35	10.9	22.3	22	52	3.4
2–0	Swiss stone pine	50	16.9	11.1	16	38	5.4
3–0	.....do	50	18.3	18.2	21	55	3.5
2–0	Digger pine	10	14.9	17.8	23	57	2.9
2–0	.....do	10	15.2	17.9	23	58	3.0

[1] Twenty trees were measured for each combination of species and age class except digger pine, for which 40 trees were measured.

INVENTORY

Each nurseryman must know the number of trees, by species and age class, in his nursery so nursery and fieldplanting activities can be properly coordinated and costs of production can be determined. As it is normally impractical to make 100-percent counts, adequate sampling must be employed. Because of the more rigorous climate, stands of conifers in Plains nurseries are generally not as uniform as those elsewhere in the country; thus, a larger sample is required to secure estimates within the required accuracy limits. Methods needed to obtain the counts are the same as those necessary in the South (Wakeley 1954) or the Lake States (Stoeckeler and Jones 1957).

An inventory which considers the causes of variation in the average stand per square foot of producing area should be made for each seeding. These variables may include seed source, age of stock, species, year of seed collection, season of sowing or transplanting, and other factors. The cost of this inventory should be only a few cents per thousand seedlings if the percentage of sample is properly gaged to the overall totals of the classes listed above.

For the seedling inventory, it is common practice to make two estimates—one of the total living seedlings in a nursery block, or unit of it, and another of the percentage of these seedlings that are plantable. The accuracy of the final estimate of tree numbers will be increased if (1) the random or systematic location of sampling points provides a good cross section of conditions on the entire area; (2) the counts are made accurately; (3) the grading specifications used to determine the percentage of seedlings in the sample that are plantable are the same as will be used at the time of lifting and shipping; and (4) the person making the inventory is not biased.

A 4.0- by 0.5-foot strip across the seedbed is a common sampling unit of inventory in the Lake States (Stoeckeler and Jones 1957); a 4- by 1-foot strip is usually used in Southern nurseries (Wakeley 1954). More samples can be obtained from the smaller strip in the same time, and they will yield more accurate estimates of the total, especially where the beds are nonuniform.

The area is defined by a frame of wood, steel welding rods, or flat steel strips reinforced with one or more crossbars. The frame may be open at one end for ease of placement on the bed, but it should be rigid enough to have a constant inside dimension of the sample size desired.

The number of 4.0- by 0.5-foot sample counts that can be taken per 8-hour day where seedlings average about 45 to 50 per square foot is as follows (Stoeckeler and Jones 1957):

Class of stock	*Sample counts (number)*
1–0	120–160
2–0	90–120
3–0	80–100

The intensity of the sample taken will be determined by the accuracy of the count required, the purpose of the inventory, and the area and uniformity of stocking of the seedbeds and transplant beds. More samples are required for nonuniform beds or for areas of seedbeds that are less than 10,000 square feet, assuming that the same degree of accuracy is needed.

A 1½-percent estimate or three counts per hundred lineal feet of seedbed has been sufficient for areas larger than 10,000 square feet (2,500 lineal feet) that have a uniform density. Estimates within 5 percent of the

correct total will be obtained in two of three trials. Many nurserymen use 10 sample counts per 500-foot bed.

The location of the samples within the beds may be random or systematic, but it should be determined prior to sampling. In a systematic layout, samples are placed at regular intervals in the bed, the distance between samples depending on the total number to be taken. The sampling points are located by pacing or measuring. Counts can be made most advantageously by a two-man crew, one man working on each side of the bed and counting approximately half of the bed. To avoid duplication or misses, smaller units of the area on which the trees are counted can be marked on the ground or indicated on the sampling frame.

A prepared form is used to record the counts. The example shown below has 20 to 25 lines per sheet (Wakeley 1954).

(Name) Nursery Inventory

Compartment Number..... Length of bed.....

Date of Inventory..... Species.....

Recorder..... Seed source.....

Measurement started..... Date sown.....

N E S W end of bed (Circle one) Cultural treatment.....

Uniformity of stocking.....

Bed number	Distance along bed	Living seedlings	Plantable seedlings	Bed number	Distance along bed	Living seedlings	Plantable seedlings
	(Feet)	(Number)	(Number)		(Feet)	(Number)	(Number)

Each sample is shown separately; the trees in each lot are calculated.

The estimate of the number of plantable seedlings is obtained by digging and counting the plantable seedlings in a subsample of the plots used previously to determine the total number in a unit of the nursery. These subsamples are selected mechanically at the time the total inventory is made—for example, by marking every fourth plot for digging. About 30 subsamples per unit should be dug. Plot the percent plantable on cross-section paper over the average number of seedlings per square foot on each subsample. A straight line drawn through these points gives an estimate of percent plantable over density for a particular unit of the nursery. The average density of seedlings per square foot in the nursery unit is then determined, and the percent plantable for this density is read from the graph. This percentage is then applied to the estimated total number of seedlings in the nursery unit to obtain an estimate of the number plantable. Allowance must be made for seedling growth from the time of inventory to time of shipment and for mechanical injury during lifting. The accuracy in making corrections can be improved by careful observation and study, and the nurseryman should attempt to develop a set of correction factors for his own nursery.

Because of greater uniformity in transplant beds, less intensive sampling is required for the same accuracy. The sampling unit for machine-transplanted trees is generally a 6-foot-long section of an individual row. When transplanting is done across the bed with 4- to 6-foot-long transplant boards, the sampling unit is the individual row corresponding to the bed width. In counting transplants a 6-foot-long wooden pole (or one corresponding to the bed width) with a long, thin nail or heavy, 4-inch-long wire bent at right angles to the pole at each end will serve as a sampler.

Where there are about 30 transplants per 6 feet of row, 160 to 200 samples are counted per 8-hour man-day. The percentage of plantable trees in transplant age classes can be estimated very closely on the basis of stem caliper and height, so no digging of samples is required.

SOIL MANAGEMENT

The problems in selecting a nursery site in the Plains with the best combination of physical and chemical soil characteristics for conifer production have already been emphasized. Furthermore, since both tops and roots of the trees grown in the nursery are removed from the soil, continued high-level production of quality stock requires systematic replacement of the nutrients.

This section presents soil management practices designed to develop the nursery soil into its highest productive state and to maintain it in that condition. Major subjects discussed are fertility requirements for conifer production, determination of nutrient needs by soil testing and visual observation of symptoms of malnutrition, application of chemical and organic fertilizing materials, maintenance of soil acidity at favorable levels for conifers (pH may change as a result of irrigation), and the great importance of soil inhabiting organisms such as mycorrhizal fungi to seedling development and their introduction into nursery soils.

Many experiments, replicated 4 to 10 times, were installed in four nurseries and more than 1,000 beds in the Dakotas to test soil fertility and pH adjustment. Randomized blocks, Latin squares, and similar statistical designs were used. In the following discussion details from a few of these experiments are presented to illustrate certain effects.

FERTILITY REQUIREMENTS AND THE DETERMINATION OF NUTRIENT NEEDS

A proper level of soil fertility and physical condition is a prime essential to good nursery management. The fertility level is important not only in producing adequate growth but also in imparting frost hardiness (Kopitke 1941) and drought hardiness (Shirley and Meuli 1939).

Based on the analysis of the surface 6 to 8 inches of soil of a number of nursery beds in the Northern Plains where good seedling growth was observed, adequate levels of fertility were determined to be as follows (Stoeckeler and Arneman 1960):

Total nitrogen (percent)	0.13
Available nitrogen (pounds per acre of ammonia and nitrate nitrogen)	40.0
Organic matter (percent)	2.5
Available phosphorus (pounds per acre of P_2O_5)	150
Available potash (pounds per acre of K_2O)	250
Cation exchange capacity (milliequivalents per 100 grams)	12.0
Replaceable calcium (milliequivalents per 100 grams)	10.5
Replaceable magnesium (milliequivalents per 100 grams)	2.4
Total replaceable bases (milliequivalents per 100 grams)	14.2
pH (for juniper species)	6.5–7.5
pH (for ponderosa and Austrian pine)	6.0–7.0
pH (for spruces, Scotch pine, and jack pine)	5.5–6.3

Testing procedures are those compiled by Wilde and Voigt (1955).

Soils of the Plains usually have large calcium, magnesium, and potassium contents. Soils with the recommended texture selected for conifer nursery purposes are likely to be deficient in phosphorus and occasionally in nitrogen. Some sulfur deficiency is reported for general farm crops in eastern Nebraska (Jordan and Reisenauer 1957), and some boron response has been noted in eastern Nebraska, Kansas, Oklahoma, and western Texas (Russel 1957). Norum et al. (1957) report for the Northern Plains a general phosphate response, some nitrogen response, and an iron deficiency in calcareous soils.

The best quick method to determine any shortage in nutrients is to take 6 to 12 samples from the surface 8 inches of soil of the nursery, keeping the samples separate by past cropping and soil treatment history, soil texture, and topographic variations, and referenced to a map of soil type. The soil samples, properly labeled, can be tested at the agronomy and soils department of the agricultural colleges, generally on a standard cost basis. Directions in labeling, packaging, shipping, and payment will be supplied by these departments or county agents. In the test, at least the following five items must be determined: Total nitrogen, available phosphorus, available potassium, pH, and silt-plus-clay content.

The tests for total nitrogen, available phosphorus, and available potassium, when compared with the fertility table, will usually reveal any serious deficiency. Because of different extraction methods, soil testing techniques are likely to indicate different quantities (in pounds per acre) of available phosphorus and available potassium. Consequently, it is sufficient that the contents of both of these nutrients rank as high or very high, regardless of the method used. Fertilizer should be applied to remedy shortages. Fertilizer test plots can be used to verify the need and degree of response.

The tests for pH should be electrometric; they will reveal actual or potential alkalinity problems and the amount of acidification, if any, that is needed. The silt-plus-clay content provides a good general guide, especially on the first soil tests run on the site, as to its probable water-retaining ability and cation-exchange capacity. The areas with the lowest silt-plus-clay content are most likely to be low in water-holding capacity, organic matter, and nutrients generally. These deficient spots may need more manure, peat, compost, and commercial fertilizers than do the areas of higher silt-plus-clay content. Differential treatment of the nursery areas based on soil analysis will result in maximum overall benefits from the fertilization.

VISUAL SYMPTOMS OF MALNUTRITION

Soil tests help provide estimates of the probability of specific nutrient deficiency, but the nurseryman should

also use other aids. One is a small-scale test of fertilizer response. A second aid is observation of visual symptoms of malnutrition such as the vigor and evenness of growth, foliage color, and the length and vigor of needles and buds.

The chief visual symptoms of malnutrition in Prairie-Plains conifer nurseries are likely to be (1) a yellow chlorotic condition due to immobility of iron in the plant, probably induced by excess lime carbonate; (2) a purplish color in spring and midsummer on spruces and some pines due to phosphate deficiency; and (3) a patchy, uneven appearance of beds (especially in newly established nurseries) due to lack of uniform mycorrhizal inoculation, invariably accentuated by phosphate starvation.

When such symptoms of malnutrition are visible, the trees can sometimes be saved by the treatments described in table 17. In cases of advanced malnutrition, the treatment may not result in any spectacular cure, and salvaging may have to be limited to usable stock, or the beds may have to be written off as a total loss.

In alkaline soils, iron may be immobile. As a remedy, enough acidifying material is added to the soil to make it moderately acid. This action stimulates a process known as chelating, which results in mobility of the iron. The effect of organic matter aids chelating. Special iron chelates, superior to iron sulfate, have been used in some horticultural crops to correct the problem, but they have not received much use in Prairie-Plains nurseries.

TABLE 17.—*Symptoms of malnutrition in Prairie-Plains coniferous nursery stock*

Deficiency or excess	Age classes and species observed	Symptoms and other detection methods	Treatment required per acre
Mycorrhizae deficiency.	2–0 and 3–0 in jack, Scotch, and ponderosa pine, and blue and white spruce.	The beds are patchy and uneven. Mycorrhizal fungi are absent except on trees in patches of good development.	Work mycorrhizal soil, leaf mold, or compost into soil, preferably between drills, and acidify with one-half to 1 ounce of iron sulfate or aluminum sulfate applied in solution per square foot. If tests show available phosphate to be low, apply 600 lbs. of 20-percent superphosphate or its equivalent per acre.
Phosphate deficiency.	1–0, 2–0, and 3–0 in white and blue spruce.	1–0 and 2–0 stock has a purplish needle color in late spring and midsummer; it is sometimes yellowish in 3–0 stock. Needles are short and may turn brown, terminal buds are poorly developed, and lateral buds are weak or absent. Soil tests may show low available phosphorus content.	Apply 600 to 1,000 pounds of 20-percent superphosphate per acre or 680 pounds per acre of 11–48–0 ammonium phosphate.
Iron deficiency.....	1–0 and 2–0 in ponderosa and jack pine.	Trees tend to have pale yellow-green needles. Soil may be alkaline in reaction.	Use iron chelates or apply iron sulfate as a foliage spray in a 1-percent solution, wetting needles thoroughly. If not cured, repeat treatments using up to one-fourth avd. ounce per square foot of iron sulfate.
Excess alkalinity.....	All age classes of ponderosa, Scotch, and jack pine.	Trees have stunted buds and yellow or greenish-yellow needles. Soils may be in a pH range of 7.7 to 8.8.	Rake 1½ avd. ounces of aluminum sulphate per square foot between drills or rows and water heavily.

The worst deficiency problems are often interrelated. Problems such as excessive alkalinity may result in iron and phosphate starvation and probably manganese starvation, and also in spotty distribution of mycorrhizal fungi. Often a drastic lowering of pH results in a chain-reaction benefit that increases the availability of three or four nutrient elements, furthers growth of mycorrhizal fungi, and suppresses certain damping-off and root rot organisms.

Some colors, such as purple, bronze-purple, or violet, may be misinterpreted. Purpling is the normal fall color change of some species, especially 1–0 seedlings of some pine species and eastern redcedar. (See section on hardening-off). The degree of color change is less in the second-year or older pine stock, but it occurs in older age classes of eastern redcedar. The purpling due to fall color change persists until late spring, when it disappears. The purpling due to phosphate deficiency is apparent throughout the growing season.

FERTILIZER APPLICATIONS AND THEIR RESULTS

To obtain the maximum benefit from fertilizing materials, nursery soils should be at the optimum pH level for the species being produced and should be well supplied with organic matter and mycorrhizal fungi. The lack of one or more of these requirements may reduce the effect of fertilization.

A study of response by Rocky Mountain juniper to a number of organic and chemical fertilizer combinations, with and without acidification, was made at the Towner Nursery in North Dakota; each treatment was replicated 10 times on 4-foot-square subplots (table 18). The nursery soil was a Sioux loamy sand. Size was not increased because of acidification (treatment 2), but there was a strong response in size due to complete commercial fertilizer (treatment 8), to manure (treatment 7), to commercial fertilizer plus peat (treatment 9), and to commercial fertilizer plus manure (treatment 10). Of the three major fertilizers, nitrogen gave the most response (treatment 3), phosphorus some (treatment 4), and potash none (treatment 5). Only peat gave no response (treatment 6).

Colorado blue spruce reacted quite differently (table 19). Fertilizer alone gave no appreciable response. The acid treatment alone or in combination with mycorrhizal soil or Nitrophoska gave the most effect, doubling the weight of plants but, probably because of acid injury, lowering the number of trees slightly. Other spruces, and most pines, tended to respond somewhat similarly to the Colorado blue spruce to acidification and fertilizers. Each treatment was replicated five times in a Latin square, with 4-foot-square subplots.

TABLE 18.—*Effect of fertilization and acidification on 2–0* Juniperus scopulorum *at Towner Nursery, Towner, N. Dak.*

Treatment no.	Treatments per unit of area [1]	2–0 trees per square foot	Length		Stem diameter	Total green weight per plant	Top-root ratio based on weight
			Top	Root			
		Number	*Inches*	*Inches*	*64ths inch*	*Grams*	
1	None	3.8	5.6	9.1	8	7.44	2.7
2	Aluminum sulfate, 1 ounce per square foot	3.6	5.6	8.7	7	8.21	2.7
3	Ammonium sulfate, 400 pounds per acre	4.0	6.2	9.8	7	9.43	2.8
4	Superphosphate, 800 pounds per acre	3.7	5.9	9.5	9	8.93	2.6
5	Potash, 200 pounds per acre	4.0	5.4	9.2	8	6.95	2.8
6	Towner peat, 20 tons per acre	4.3	5.4	9.1	8	6.95	2.7
7	Sheep manure, 20 tons per acre	3.5	6.5	9.5	9	10.42	2.8
8	Ammonium sulfate, 400 pounds; superphosphate, 800 pounds; potash, 200 pounds per acre	4.5	5.6	9.2	8	9.20	2.7
9	Ammonium sulfate, 400 pounds; superphosphate, 800 pounds; potash, 200 pounds; Towner peat, 20 tons per acre; aluminum sulfate, 1 ounce per square foot	4.3	6.4	9.6	9	10.09	2.9
10	Nitrophoska, 100 pounds; sheep manure, 20 tons per acre; aluminum sulfate, 1 ounce per square foot	3.5	7.5	9.7	10	13.36	3.2

[1] All peat was applied on an ovendry weight basis. The fertilizers used were 20–percent ammonium sulfate, 20–percent superphosphate, 50–percent muriate of potash, 15–30–15 Nitrophoska, and ordinary commercial aluminum sulfate.

TABLE 19.—*Effect of soil amendments on size of 2–0 Colorado blue spruce, Towner Nursery, Towner, N. Dak.*

Treatment per square foot of bed	Trees per square foot at 2–0 age	Length		Stem diameter	Green weight per plant	Top-root ratio based on weight
		Top	Root			
	Number	*Inches*	*Inches*	*64ths inch*	*Grams*	
None	21.6	1.8	7.5	3.3	0.98	1.00
Three-eighths ounce of sulfuric acid (diluted)	14.2	3.1	7.3	4.8	2.12	1.09
One-fourth ounce of 15–30–15 Nitrophoska	21.5	1.9	6.6	3.3	1.04	1.00
Three-eighths ounce of sulfuric acid plus 1 pound of mycorrhizal soil	20.7	3.0	7.1	5.2	2.40	1.07
Three-eighths ounce of sulfuric acid plus one-fourth ounce of 15–30–15 Nitrophoska plus 1 pound mycorrhizal soil	18.6	2.8	7.6	4.7	1.99	1.31

Nitrogen.—Nitrogen has been applied to the soil at the time of ground preparation. Application has usually been at the rate of 40 to 80 pounds per acre, usually in the form of 20 percent ammonium sulfate (200 to 400 pounds per acre). Sometimes it is applied in a complete fertilizer, such as 600 pounds per acre of 15–30–15 or 15–35–15. When applied at moderate amounts in properly modified soil, adequate stands were obtained.

Overtreatment with concentrated nitrogen fertilizers can cause increased damping-off or actual chemical injury and may reduce the tree stand (fig. 44).

Sodium nitrate applied as a preseeding treatment greatly reduced a stand of 1–0 ponderosa pine. For treatments of 0, 400, 800, and 1,200 pounds per acre, the stands per square foot were 54, 31, 20, and 18 seedlings, respectively.

When beds are acidified at the time of fertilization with nitrogen-supplying materials rototilled into the soil, losses from subsequent damping-off are minimized. This point is discussed in a succeeding section on maintenance of proper pH.

Phosphorus.—Phosphorus often is the key element in short supply. When applied at 340 to 680 pounds per acre of 20-percent superphosphate, it has given good response. In fact, in some trials as much as 1,320 pounds per acre was used with optimum response. Phosphorus is also applied in mixed fertilizers. At most nurseries, use of 600 to 800 pounds per acre of 20 percent superphosphate has been sufficient, even for the most deficient situations.

Potassium.—If required, about 100 to 200 pounds of potassium sulphate can be supplied.

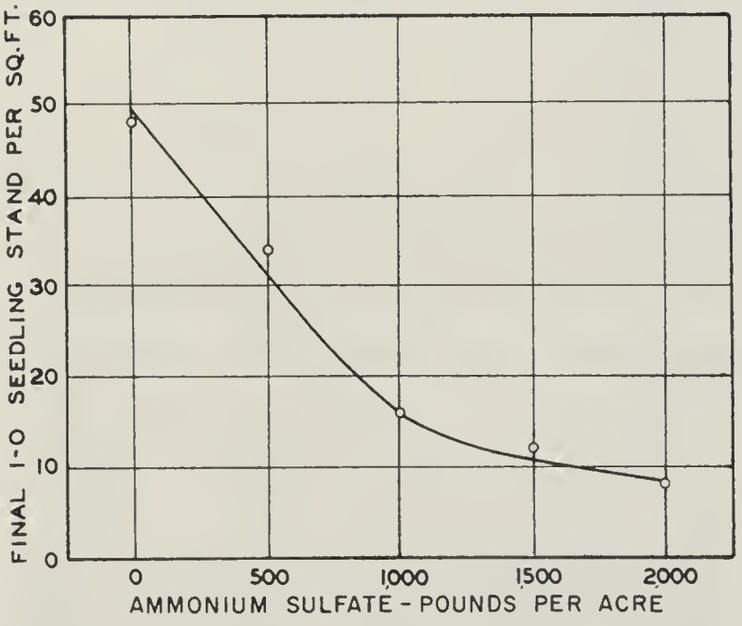


FIGURE 44.—This graph shows an example of heavy treatments of nitrogen fertilizers. A small-scale experiment using 20-percent ammonium sulfate worked into the top 6 inches of soil before seeding on June 9 caused a reduction in 1–0 ponderosa pine tree stand due to damping-off and chemical injury. The beds had not been acid treated. Stand differences are highly significant statistically. Towner Nursery, Towner, N. Dak.

Calcium and magnesium.—Calcium or magnesium has not been deficient in Prairie-Plains conifer nursery soils. In fact, an excess has sometimes been a problem.

Iron.—Iron sulfate can be applied as a 1-percent foliage spray to wet the needles thoroughly in case of mild chlorosis (Korstian et al. 1921), in amounts of about 25 pounds per 50 gallons of water per acre (Imperial Institute of London 1936), or with more massive doses of 680 pounds or more per acre applied as a powder at time of seeding or in solution on established beds. Use of iron chelates has definite potential for correcting chlorosis (Haertl 1955, Stewart and Leonard 1952). For some horticultural crops, application of iron chelates, at 5 to 10 pounds per acre, has been effective in correcting chlorosis. Often much heavier treatments are necessary, and the treatment may be quite costly, especially if 20 or more pounds should be required per acre. There is little or no experience regarding the value of chelates on coniferous nurseries in the Prairie-Plains.

Manganese.—This element can be supplied as a manganese sulfate powder, disked in before seeding. In one experiment its application, at 340 pounds per acre, doubled the ponderosa pine tree stand at the 1–0 and 3–0 stages (apparently due to damping-off control) but did not increase growth. The Imperial Institute of London (1936) mentions its use, at 50 to 100 pounds per acre, as early as 1936.

Useful references on soil fertility include those of the Chilean Nitrate Educational Bureau, Inc. (1948), Mayer-Krapoll (1956), Stoeckeler and Arneman (1960), White and Leaf (1956), and Wilde (1958).

LIQUID FERTILIZERS AS TOPDRESSINGS

Liquid fertilizers have been applied as topdressings in early June on offcolor beds with some success. Among those that have given good results are (1) one-eighth ounce of 15–30–15 fertilizer per square foot applied in June on 2–0 blue spruce (fig. 45); (2) one-fourth ounce of 11–48–0 ammonium phosphate per square foot applied in June on 3–0 white spruce; and (3) one-twelfth to one-eighth ounce of 20-percent ammonium sulfate per square foot on first- or second-year pines or spruces. At the Bessey Nursery on 2–0 stock, urea has been found effective when applied in early June in a dilute solution at 0.042 ounce of urea per square foot (equivalent to 50 pounds of nitrogen per acre).

Liquid fertilizers generally are not applied more than once a year; however, at the Bessey Nursery 2–0 stock has sometimes received two treatments; each time 0.092 ounce of 20-percent ammonium sulfate per square foot was used. Regardless of the type of liquid fertilizer used, overhead irrigation should follow immediately after treatment to wash the fertilizer off the foliage and prevent fertilizer burn.

Liquid fertilizers can be pumped through the overhead system or applied from an acid barrel. In the

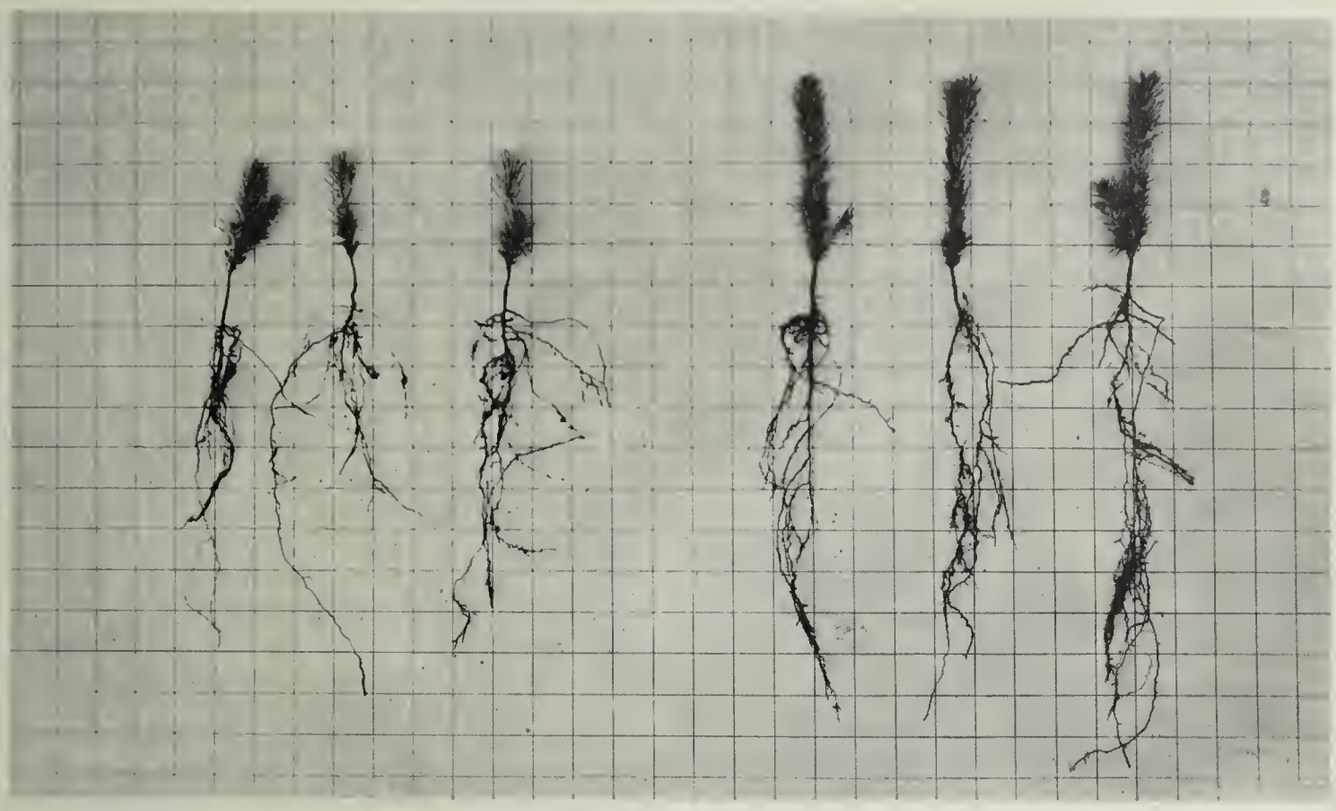


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FIGURE 45.—Liquid fertilizers can improve the growth and color of the seedlings. These are 3–0 blue spruce at Towner Nursery, Towner, N. Dak. At left, three trees from an unfertilized bed; at right, three trees from a bed given a liquid topdressing of one-eighth ounce of 15–30–15 fertilizer per square foot of bed in June of the previous season.

latter case, the water-soluble fertilizer is placed in a sack and hung in the acid barrel to prevent clogging of the holes in the pipe.

MANURE, COMPOST, LEAF MOLD, AND PEAT

Bulk organic matter has been used with considerable success in the Plains nurseries. Animal manures are most often used; however, various composts are also applied, and development of a peat supply may have promise in the north.

The chernozemic soils of the Northern Plains are generally rather well supplied with humus (Nikiforoff 1938), but prolonged cropping gradually depletes it. Regular application of farm manures in crop rotations is the best means of reducing the rate of nitrogen depletion (Haas and Evans 1957). The beneficial long-range effect of farm manures has been well documented (Haas and Evans 1957, Salter and Schollenberger 1938, Van Slyke 1932). However, if animal manures are used, application should be confined to cover crops or transplants or as an ingredient in compost since their use may accentuate the damping-off and weed problems. They should be left in the compost pit for at least 1 year before use in the nursery. Application of 20 to 40 tons per acre has produced excellent results.

At the Bessey Nursery, until 1953, a compost was made up of 2,000 pounds of weeds, grass, or other vegetative material, 25 pounds of ammonium phosphate, and 300 pounds of calcareous clay. The clay and fertilizer were mixed and layered between the weeds and kept moist. This material, slightly richer than barnyard manure, was composted for 2 years before 20 tons per acre was applied just before the rye cover crop was plowed under.

In the Southern Plains, higher rainfall intensities, higher temperatures, and a longer warm season deplete the humus reserve more rapidly than in the north, and the use of bulk organic matter (animal manures or composts) in the nursery becomes even more necessary. Here there is prospect of using straw, and sawdust in the more easterly areas, as an ingredient in making composts (Allison and Anderson 1951, Feustel 1938).

Leaf litter has been an excellent material for soil improvement in nurseries in forest regions (Lanquist 1945, Wilde 1946). Leaves that have been raked up from trees along streets have also been used to advantage (Stoeckeler and Jones 1957). Leaf mold can sometimes be obtained in the Prairie-Plains from natural stands in bottomlands or hill areas.

Peat deposits with organic matter that can be added to nursery soils can occasionally be found in the Northern Plains. These peats tend to have a high pH level. The range in one bog near Towner, N. Dak., was 6.0 to 7.6, and in most places the pH was about neutral. This peat, when used experimentally at 10, 25, and 50 tons per acre on new seedings of ponderosa pine

without acid treatment of the beds, had no deleterious effect on the tree stand. An application of sheep manure, however, drastically reduced the stand from 58 to 22 trees per square foot, and seeding density, from 38 to 14 (fig. 46). The loss was due to damping-off.

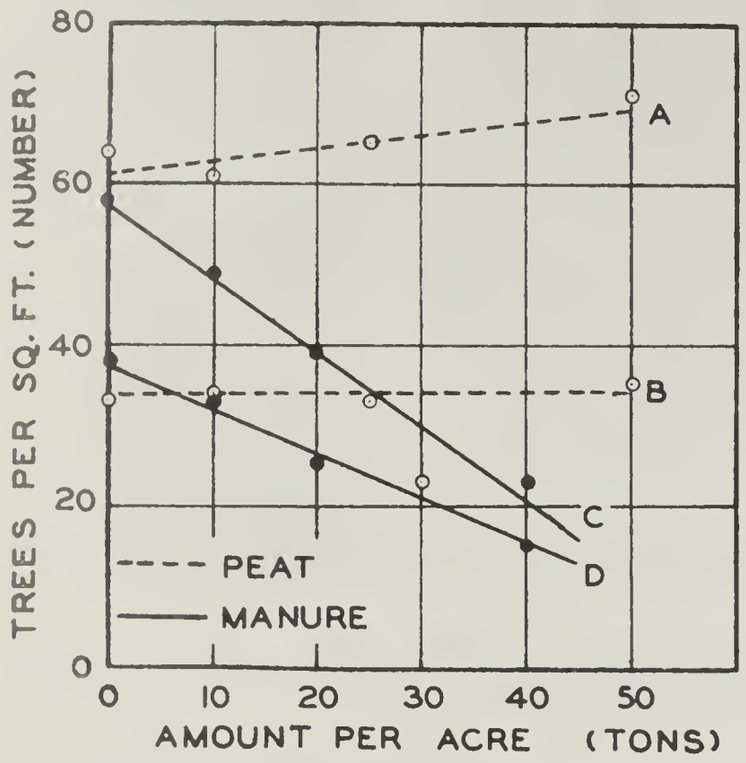

FIGURE 46.—Comparison of 1–0 stands of ponderosa pine as affected by two rates of seeding and by the application of various amounts of moderately acid peat (*A* and *B*) and sheep manure (*C* and *D*) to beds just before seeding. No acid treatment was used. *A* and *C* were sown at the rate of 116 viable seed per square foot. *B* and *D* were sown at 58 viable seed per square foot. The peat treatments had no adverse effect on the stand. The manure was highly deleterious (at a 1-percent level of significance). Towner Nursery, Towner, N. Dak.

COVER AND SOIL IMPROVEMENT CROPS

Many Plains nurserymen use a cover crop at least once every 3 or 4 years in the rotation. Cover crops have three primary purposes: (1) To prevent soil blowing on land not occupied by trees, (2) to add organic matter, and (3) to keep the weed problem reasonably controlled on land without trees.

Cover crops used commonly in the Prairie-Plains conifer nurseries are Hubam clover, soybeans, biennial sweetclover, rye, oats, sweetclover, field peas, cowpeas, and vetch or a rye-vetch mixture. Hubam clover has been used in the Dakotas, and cowpeas and soybeans in the Central and Southern Plains.

Cover crops that are hosts to various nematodes should not be used. An example is the soybean cyst nematode found in States east of the Prairie-Plains. This nematode is difficult to eradicate from infected fields, and stock from such fields likely would be quarantined.

Leguminous cover crops may add as much as 100 to 150 pounds of nitrogen per acre; they also may supply several tons of organic bulk per acre (Chadwick 1938; Pieters and McKee 1938; Rogers and Giddens 1957).

Cover crops require some irrigation in dry periods and may require fertilization. The legumes, particularly, cannot be expected to produce worthwhile crops without some supplemental water.

Cover crops are plowed under shortly before or during the first development of flowers, or they may be mowed at that time so that seed formation can be avoided and an erosion-preventing mulch can be retained on the surface. Rye is often seeded in late summer in paths and at bed ends as well as on fallow land. It creates enough cover to give good overwinter protection. All cover crops should be plowed under 4 to 6 weeks in advance of seeding. Many nurserymen prefer to use them in the rotation before transplanting rather than before seeding.

In North Dakota nurseries, biennial white sweetclover is sometimes sown in May of one year, and plowed under in May or June of the following year.

In Canadian nurseries, under semiarid conditions, cover crops such as millet, rye, Sudangrass, and barley all produced 2 to 4 tons of dry material per acre when given several inches of irrigation (Knight 1956).

At the Bessey Nursery in Nebraska, the policy is to use a cover crop every third year. Whippoorwill cowpeas are sown at the rate of 1½ bushels per acre in early May and plowed under in late July or in the early blossom stage; the area is left fallow until early September and then sown to winter rye. Sometimes rye can be a problem following its incorporation into the soil because incompletely decomposed plant residues tend to interfere in subsequent seeding or planting. Oats may be superior to rye in this situation.

The amount of organic matter and nitrogen supplied by a cover crop is rather small compared with that furnished by the usual 10- to 20-ton treatment per acre of compost or manure. In many instances excellent crops of trees have been grown for a prolonged period without use of a cover crop. For example, at the Towner Nursery, one tract without cover crops was used continuously for 10 years and each tree crop was more vigorous than the previous one. Organic matter in the form of manure was used liberally.

MAINTENANCE OF PROPER pH

The pH of the soil is an expression of its relative acidity or alkalinity.[18] Many agricultural plants grow quite well over a wide range of pH, often 5.0 to 8.0, while others require a soil well supplied with lime and preferably slightly alkaline (Allaway 1957).

[18] A soil with a pH of 3.5 would be considered extremely acid; about 5.0 to 6.0, moderately acid; 7.0, neutral; 7.5 to 8.0, moderately alkaline; and 8.5 to 9.0, extremely alkaline. Very acid soils are low in lime, while very alkaline soils (above pH 8.5) have an excess of salts or alkalies which adversely affects physical characteristics and water relations of the soil and may depress or kill plant growth.

The maintenance of the proper pH of the soil is very important in Plains nurseries. Serious errors can result in extremely high costs per thousand salable trees or even in stand failure.

Among conifers commonly grown in Prairie-Plains nurseries, eastern redcedar, Rocky Mountain juniper, and Siberian larch grow well in circumneutral soils at a pH of 6.0 to 7.5. Ponderosa and Austrian pines have done well at a pH of 5.5 to 7.2, and white spruce, blue spruce, jack pine, and Scotch pine have grown best in a moderately acid soil of about 5.5 to 6.5.

Broadleaf species generally tolerate more alkalinity than do conifers (Stoeckeler 1946), and young conifer seedlings tolerate less than transplants or older stock.

The chief problem encountered in Plains soils is alkalinity. An inherently high content of carbonates is accentuated by additional carbonates in irrigation waters. The problem is more acute if the nursery soil has poor internal drainage. Often soils that were slightly acid (6.2 to 6.5) before irrigation have a pH change to 7.5 to 7.7 after 1 or 2 years' irrigation, with great subsequent harm to the conifers because of serious damping-off, root rot (Davis 1940), and phosphate and iron starvation. Truog (1946) states that the availability of phosphorus, iron, manganese, zinc, copper, and boron all are greatly reduced when soil pH is moderately alkaline. Treating the soil with acidifying materials such as sulfur may make iron more available (Holmes and Brown 1957). Bjorkman (1953) noted potash starvation in spruce on soils with a pH up to 7.6 and reported that mild cases were corrected by acidification.

Tests of the pH of the top 6 inches of soil should be made in a number of places to determine the probable amount of acidification required. Acidification should not be overdone, and apparently there is no need to lower the pH below about 5.3 to 5.5 in Plains conifer nurseries. When the soil acidity is lowered to a pH of about 3.8 to 4.5, magnesium and calcium deficiencies may result (Voigt, Stoeckeler, and Wilde 1958).

COMPARISON OF ACIDIFICATION WITH DIFFERENT CHEMICALS

The alkalinity of conifer seedbeds cannot be corrected satisfactorily by the usual fertilization practices. The soil must be acidified. Such treatment will greatly enhance the effects of fertilizers applied later and will improve the rate of spread of beneficial mycorrhizal fungi.

To test the effectiveness of several chemicals in correcting soil alkalinity by acidification, an experiment was conducted on a loamy sand soil at the Towner Nursery in 1938. Seedbeds of ponderosa pine were treated in the spring at the time of seeding and retested in the fall of the same year. All chemicals were applied in solution, using about 1 pint of water per square foot of seedbed.

Five chemicals (sulfuric and phosphoric acids, and aluminum, iron, and manganese sulfates) were tested at three soil depths (figs. 47 and 48).

In the spring of 1938, the top 8 inches of the untreated soil had a pH of 6.8; in the fall of the same year, after one season of irrigation, it was 7.5 for the surface 4 inches and 7.2 for the 4- to 8-inch level. Except for the weakest solutions, the applications greatly reduced the pH of the surface 2 inches of soil and somewhat reduced the 2- to 4-inch and 4- to 8-inch depths.

Considering the vigor and size of seedlings and the ultimate stand obtained, it was concluded from this and other tests that a safe, effective, and consistent treatment consisted of application of one-fourth to three-eighths fluid ounce of sulfuric acid or one-half avoirdupois ounce of aluminum sulfate per square foot for a moderately alkaline soil condition. The degree and persistence of the acidification obtained and the damaging effects on the trees were considered in this evaluation. For subsequent re-treatment of areas where previous crops had been acidified, often one-eighth to one-fourth fluid ounce of sulfuric acid or one-fourth ounce aluminum sulfate was sufficient.

In addition to the five chemicals mentioned, sulfur in fine powder form was also applied before sowing. It proved to be very effective at one-fourth to three-eighths ounce per square foot for a first application in sandy soils and at one-half ounce per square foot on alkaline silt loams (Stoeckeler and Arneman 1960). In applying this treatment, any lumps in the material must be thoroughly pulverized since acid injury may occur if rootlets of plants contact grains or chunks of the sulfur. In terms of acidifying power, 7 avoirdupois ounces of sulfur has about the same effect on pH as 10 fluid ounces of sulfuric acid (Davis, Wright, and Hartley 1942).

Flowers of sulfur tend to produce less acid injury if applied several months or a year before the germination period. However, they have been repeatedly used in a large number of experiments immediately preceding spring seeding, with no apparent acid injury and with great benefit to the growth of the more lime-sensitive tree species. In all cases the material was very well pulverized and free from grains as large as a match head.

Sulfur can be expected to be effective for a prolonged period. For instance, the effect of a heavy treatment at the Towner Nursery in 1935 lasted until the fall of 1941, when some treated areas were still in the 5.1 to 5.6 pH range. This prolonged effect is due to the slow chemical reaction and the fact that less sulfur than sulfuric acid is leached out in irrigation water.

Some treatments of one-half fluid ounce of concentrated acid per square foot, diluted to about 2 percent in water, have subsequently injured seedlings. Therefore, it is recommended that the amount of acid not exceed three-eighths fluid ounce.

Before application, the number of square feet of the seedbed to be treated is determined. The required

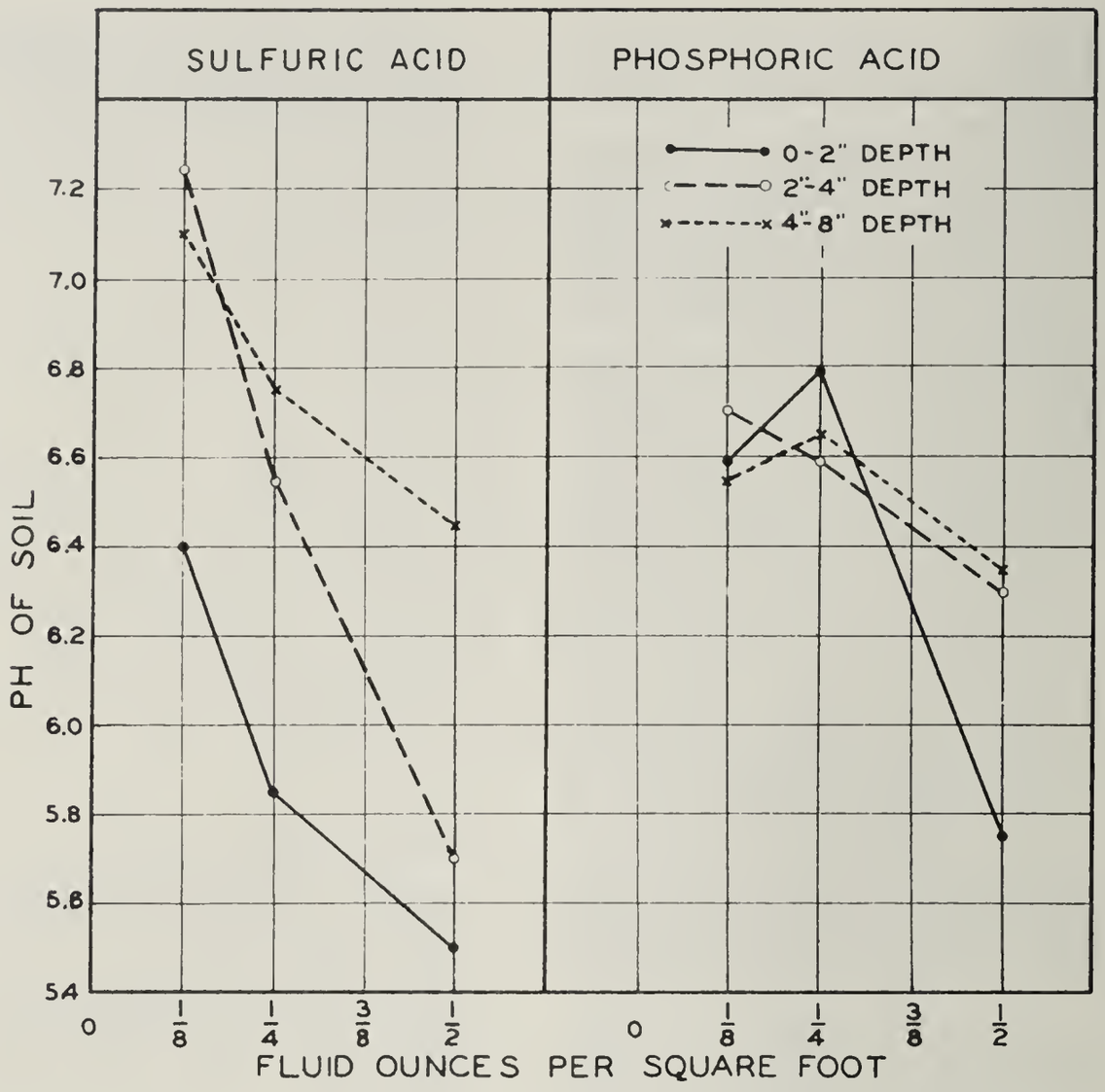

FIGURE 47.—Effect on soil pH of sulfuric acid and phosphoric acid. Applications were made in the spring of 1938, and the soil tests were made in the fall of the same year. Towner Nursery, Towner, N. Dak.

amount of concentrated acid is calculated by multiplying the desired dosage (expressed in fluid ounces per square foot) by the number of square feet. This amount is then diluted to 2 percent by volume to avoid injury to the trees. The solution is applied so that all of the treated area will receive approximately the same amount.

As noted previously, species vary in their pH preference or their tolerance of alkalinity. The lower dosages (about one-eighth fluid ounce per square foot) often sufficed for ponderosa pine. Jack and Scotch pine and all the spruces required the heavier treatments for best results. At the Towner Nursery, jack pine beds had eight trees per square foot in untreated second-year beds (pH about 7.5) while the beds treated with one-fourth and three-eighths fluid ounce of sulfuric acid per square foot averaged 30 and 51 trees, respectively (fig. 49). Untreated beds were chlorotic; treated beds were a healthy green, and average heights were double those of the untreated beds. The three-eighths ounce treatment gave the best results at the 2–0 stage.

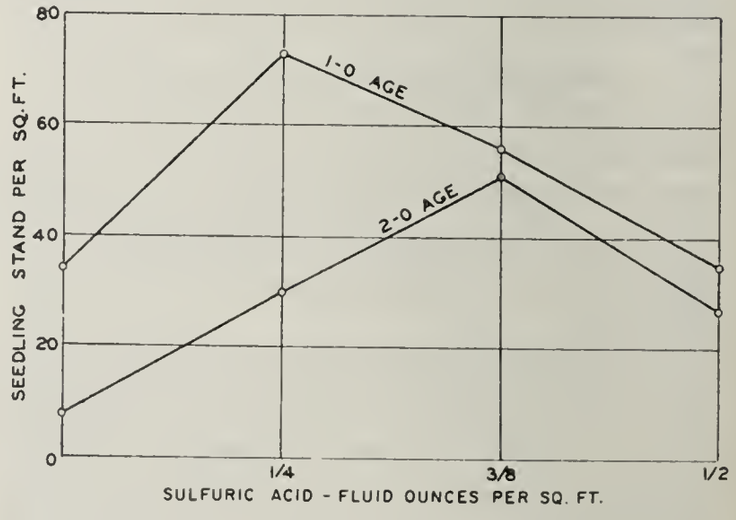

FIGURE 49.—Effect of sulfuric acid treatment of beds at the time of seeding on resulting stands of jack pine at 1–0 and 2–0 age. The seeding rate was 132 viable seeds per square foot. The acid was applied in water solution at the rate of about 25 cubic centimeters of sulfuric acid per gallon of water. Towner Nursery, Towner, N. Dak.

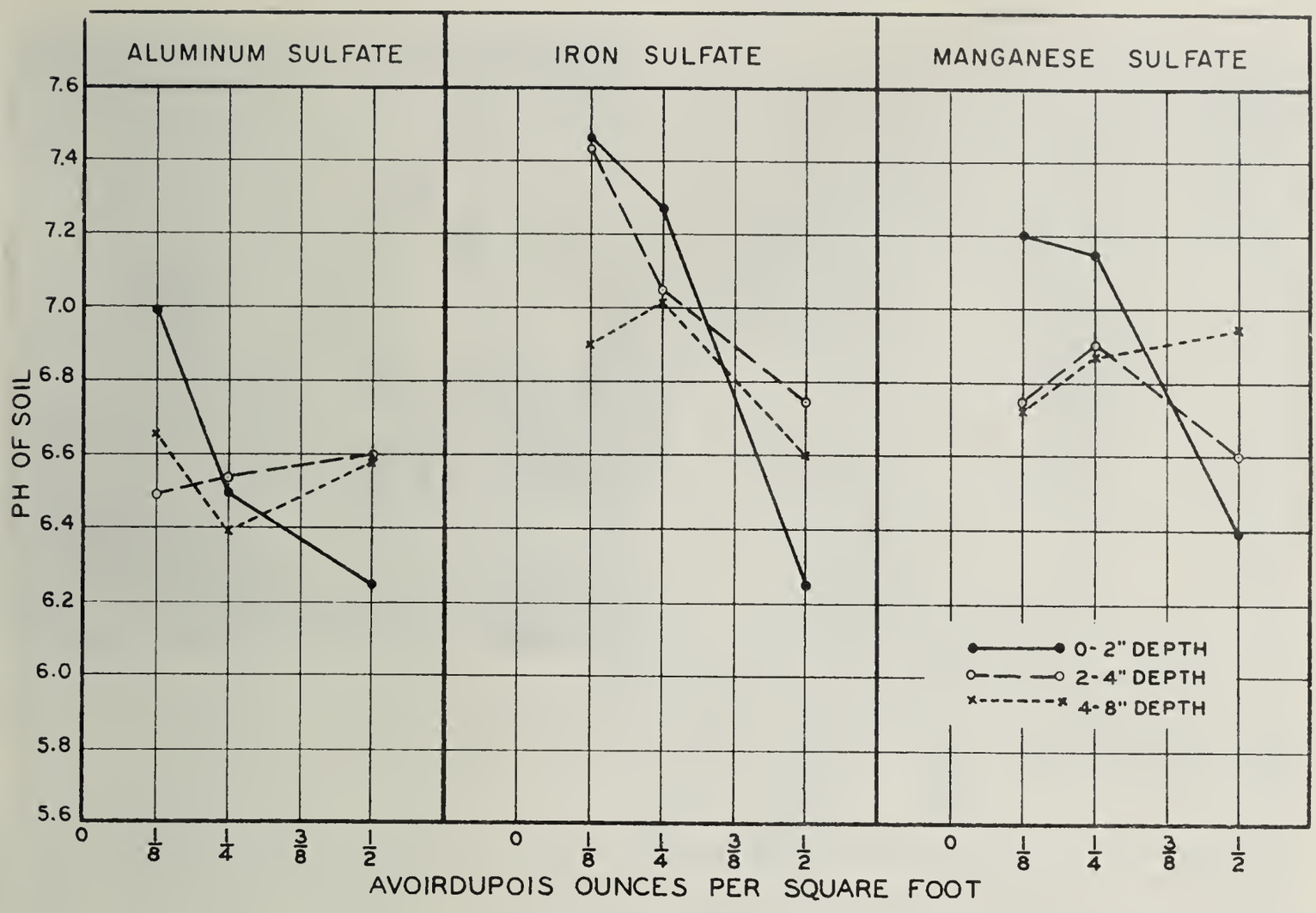

FIGURE 48.—Effect on soil pH of aluminum sulfate, iron sulfate, and manganese sulfate. Applications were made in the spring of 1938, and soil tests were made in the fall of the same year. Towner Nursery, Towner, N. Dak.

Similar results were observed in blue spruce; with this species the application of three-eighths fluid ounce of sulfuric acid per square foot doubled the weight of second-year trees. In several North Dakota nurseries, application of one-fourth fluid ounce of sulfuric acid doubled or tripled the number of usable plants produced per square foot. Results for flowers of sulfur were similar.

Variable response has been obtained in juniper seedbeds.

The response to commercial-grade aluminum sulfate also varied by species; ponderosa pine had an optimum stand when one-half ounce per square foot was applied; comparatively greater effect was obtained at higher rather than low sowing rates (fig. 50). In a trial in which 0, ½, 1, and 1½ avoirdupois ounces were used (fig. 51), the 1-ounce treatment per square foot gave the best stand of jack pine. The average heights for 2–0 trees were 1.2, 1.5, 2.0, and 2.0 inches, respectively. Color was not as good as in the sulfuric acid treatment. In the presence of an adequate phosphate

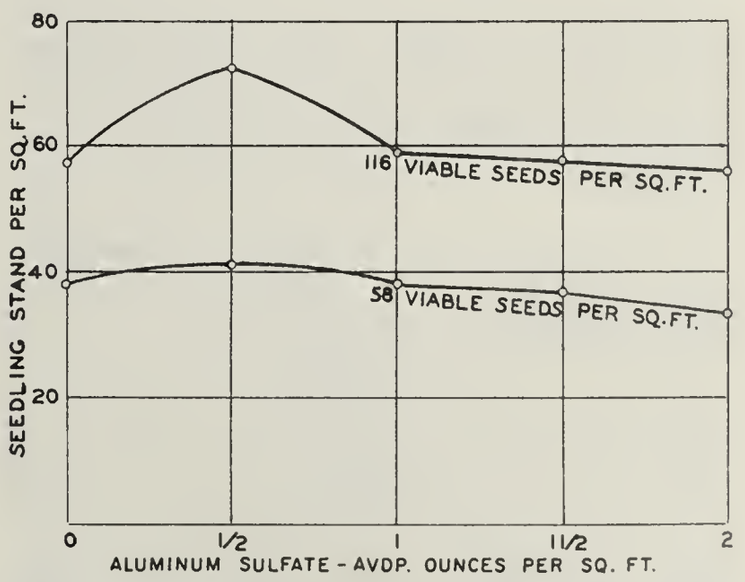

FIGURE 50.—Effect of aluminum sulfate treatment on first-year ponderosa pine seedbug stands at two densities of seeding. The chemical was raked into the top 2 inches of soil before seeding. Towner Nursery, Towner, N. Dak.

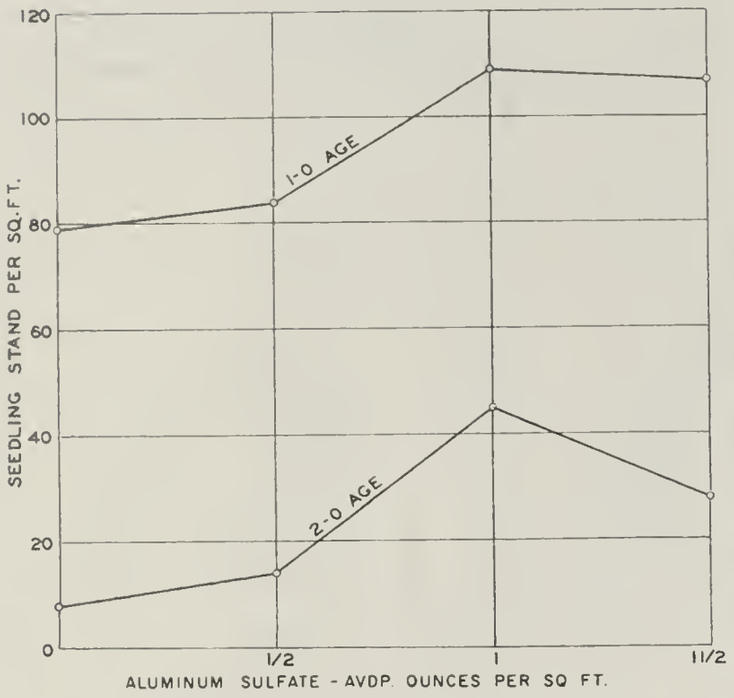

FIGURE 51.—Effect of aluminum sulfate treatment on stand of jack pine seedlings. The seeding rate was 132 viable seeds per square foot. The material was applied dry on newly seeded beds and washed into the soil by heavy sprinkling immediately after application of the chemical. Towner Nursery, Towner, N. Dak.

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FIGURE 52.—Application of dilute solution of sulfuric acid to seedbeds. Bessey Nursery, Halsey, Nebr.

level, on some occasions acidification did not increase the number of ponderosa pine trees.

Hartley (1915, 1917) did some of the early research in damping-off control at the Bessey Nursery and other nurseries. He found a marked increase in tree stand and size from acid treatment and warned against injury from concentration of acid as the surface soil dried.

Another important benefit of soil acidification is weed control. Hartley (1915) reported substantial weed control by sulfuric, nitric, and hydrochloric acid. Hartley's results were verified many years later at the Towner Nursery where the weed stand for a 1-month period after acidification was reduced substantially:

Treatment	*Chemical per square foot (ounces)*	*Weed stand per square foot (number)*
Control, untreated	0	40
Aluminum sulfate	½ avdp. oz	45
Do	1 avdp. oz	37
Do	1½ avdp. oz	29
Do	2 avdp. oz	28
Sulfuric acid	⅛ fluid oz	40
Do	¼ fluid oz	27
Do	⅜ fluid oz	20
Do	½ fluid oz	13

Acidifying materials such as sulfuric acid or phosphoric acid in about 2 percent solution are generally applied from an acid barrel immediately after seeding. A wooden barrel, steel drum, or lead-lined container drawn by hand or by tractor is used (fig. 52).

Aluminum sulfate may also be applied in solution with an acid barrel or cart. Such an application gives somewhat better damping-off control in the critical surface inch or two of soil, but it does require slightly more labor and expense than when the aluminum sulfate is applied dry with a fertilizer or lime spreader.

Acidification to maintain proper pH of the soil has been a common requirement in Plains nurseries. If soil testing indicates a need for acidification, a safe, effective, and consistent treatment is the application of one-fourth to three-eighths fluid ounce of sulfuric acid or one-half avoirdupois ounce of aluminum sulfate per square foot for a moderately alkaline soil condition.

CARRYOVER EFFECT OF ACIDIFICATION

Part of the beneficial effect of acidification may last for more than 3 years. Tests of the soil pH will indicate how much the aftereffect of an initial, rather heavy acidification has persisted. This will vary widely, depending on the amount and quality of the irrigation water used and the tree species involved.

In the fall of 1941, a great variation was observed in some beds of 3–0 Scotch pine at the Towner Nursery. These beds were part of an area which, in the spring of 1936, had been devoted to an experiment involving various levels of acid treatments including no treatment. The beds were sown to Scotch pine in the spring of 1939 without any additional soil treatment.

The extreme variation noted in size of the 3–0 Scotch pine in the fall of 1941 was correlated with the

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FIGURE 53.—Difference in size of 3–0 Scotch pine due to treatment of the soil with sulfuric acid 6 years previously. At left, three puny nonmycorrhizal seedlings from untreated areas. At right, three large mycorrhizal seedlings from a plot treated with acid. Towner Nursery, Towner, N. Dak. (One-inch squares are in background.)

acidification treatment of the spring of 1936. The better and larger trees were in the areas which had been most heavily acidified, and the poorest trees were in control beds which had received no acid treatment in 1936.

Samples of the 3–0 Scotch pine, when examined after digging, showed a heavy fungus mantle of mycorrhizal development covering the roots of the good trees. The trees from the areas of poorest development had few or no mycorrhizal fungi and few or no lateral buds surrounding the terminal bud. The contrast in the extremes of the two conditions is shown in figure 53. Similar and striking benefits from acidification were observed on ponderosa pine grown on an alkaline silt loam at Bottineau, N. Dak. (Stoeckeler and Arneman 1960).

The beneficial effect is attributed to the rapid spread of mycorrhizal fungi in the acidified beds and to the improvement in conditions for phosphate and iron assimilation in the same beds.

THE ROLE OF MYCORRHIZAL FUNGI

Mycorrhizal fungi are organisms that live in association with conifers and some hardwoods (Bergemann 1956, McArdle 1932, Melin 1927, Shemahanova 1957). The mycelia of such fungi are intimately associated with the living tissues of the roots, permitting movement of soluble carbohydrates from tree to fungus, and translocation of mineral nutrients from the fungi into the tree roots. The end result usually is increased tree vigor and growth (Wilde 1958).

According to Goss (1960), the occurrence of mycorrhizal fungi on pines, chiefly ponderosa, in Nebraska is relatively sparse in the early spring, compared to their reported occurrence at this season in the forested areas of the Eastern United States. However, he found them on pine roots growing in a wide variety of soils in field shelterbelts, in the sandy soils of the Nebraska National Forest at Halsey, and in several nursery soils. Plains areas or tracts devoid of tree growth for a long period are likely to have no mycorrhizal fungi (Dale

and McComb 1955, Goss 1960, McComb 1943, Rosendahl 1942, White 1941). If present, they may be unevenly distributed. The lack of or incomplete distribution of mycorrhizal fungi has been associated with early poor development of some of the conifers used in windbreak planting (fig. 54).

Between 1933 and 1938, an extensive series of experiments with mycorrhizal inoculations and supplementary treatments was conducted at Denbigh, Towner, Oakes, and Bottineau, N. Dak. It was concluded that ponderosa pine was favorably affected in some instances by mycorrhizal fungi, particularly where pH adjustments had been made by acidification; and that Scotch and jack pine and blue and white spruces consistently required mycorrhizal inoculation and acidification with sulfuric acid if they were to have good growth (fig. 55).

Increased growth and lessened chlorosis of ponderosa pine seedlings resulted from the addition of duff-soil inoculum to nonmycorrhizal virgin grassland soils (Goss 1960). More mycorrhizal than nonmycorrhizal seedlings were able to survive a rapid and extreme soil moisture deficiency.

Some studies in 1936 included inoculation of beds with pure cultures or mycorrhizal nursery soil. These tests demonstrated clearly that the specific mycorrhizal fungi involved did not thrive in an alkaline soil (pH about 7.5). However, when the soil was acidified sufficiently to lower pH to 6.0, they grew well.[19]

Mycorrhizal fungi can be introduced into prairie and plains soils by one of several methods:

1. Incorporation of leaf mold, humus, and surface soil (surface 2 to 3 inches) from a well-established plantation or shelterbelt of spruce or pine or from a natural stand.
2. Incorporation of surface soil from a well-established nursery that is free from the more serious disease and insect pests and has nursery stock showing an abundance of mycorrhizal fungi.
3. Incorporation of compost made of stockpiled leaf mold and peat containing mycorrhizal fungi over the nursery beds.
4. Transplanting some pine or spruce seedlings obtained from a nursery where the mycorrhizal fungi on the seedling stock are abundant.

The more successful of these methods has been the use of mycorrhizal soil or seedlings from natural stands

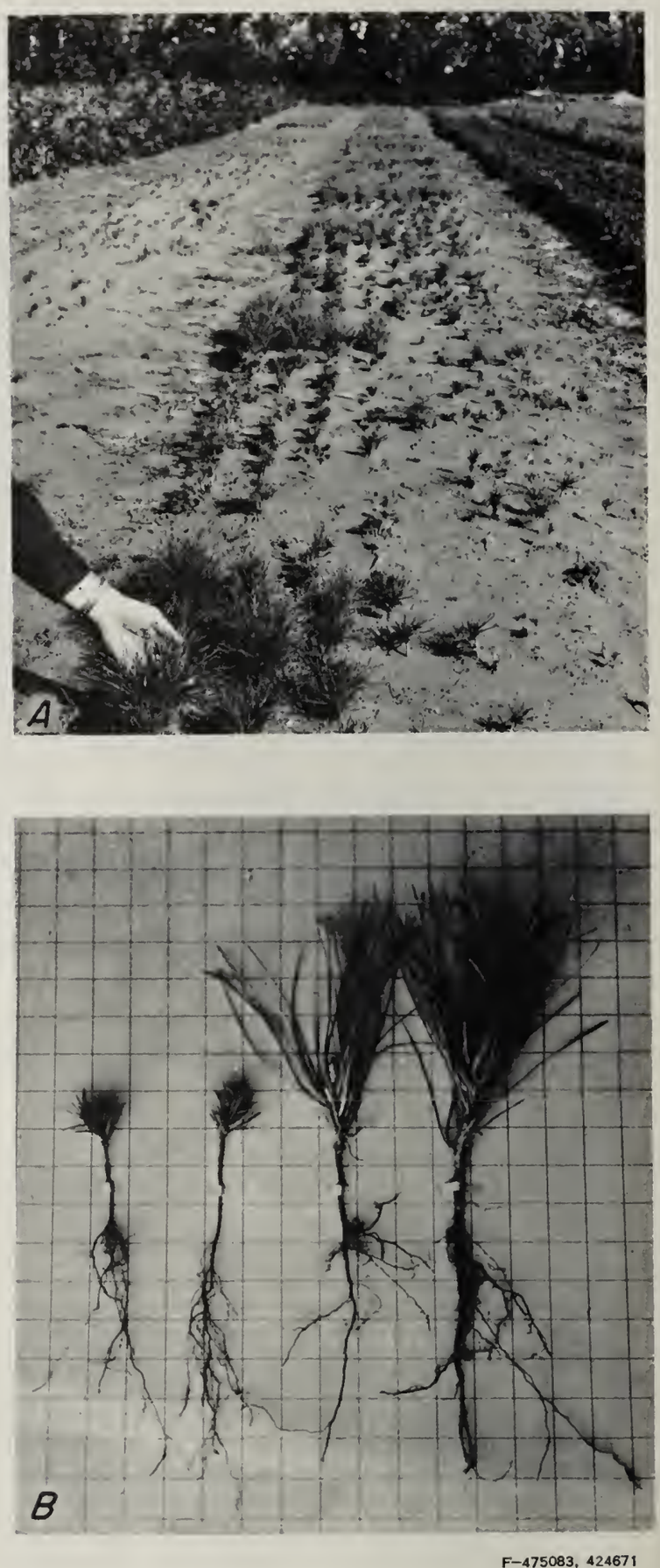

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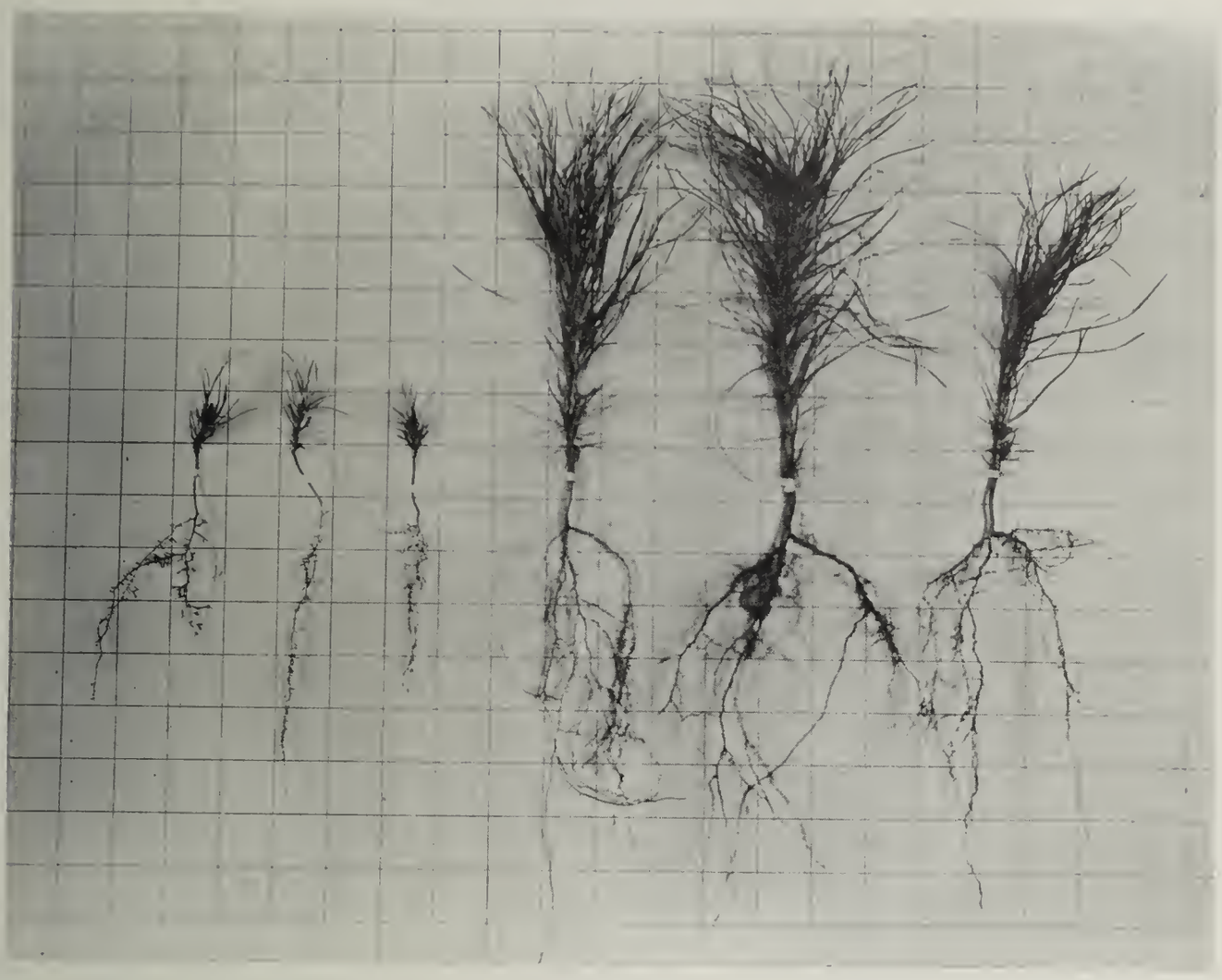
FIGURE 54.—*A*, Patchy, uneven condition of second-year untreated beds of ponderosa pine in a North Dakota nursery caused by uneven distribution of mycorrhizal fungi and aggravated by soil alkalinity. *B*, Closeup of mycorrhizal (right) and nonmycorrhizal (left) seedlings lifted from good and poor areas in the above nursery. (One-inch squares are in background.)

[19] The pure cultures were supplied by Dr. K. D. Doak of the then Bureau of Plant Industry, Washington, D.C. Wheat was boiled 4 hours and then cooled before inoculation with specific strains of mycorrhizal fungi and other fungi. These spread throughout the glass jar container within 4 to 6 weeks after inoculation. The species used included: *Boletus granulatus,* a mycorrhizal fungus found beneficial to certain conifers native to or introduced into the Eastern United States (including Scotch, eastern white, jack, pitch, and red pine); *Ithyphallus ravenelii,* a nonmycorrhizal fungus which, according to Dr. Doak, has benefited Scotch pine and some spruces and firs; *Clitopilus abortivus;* and *Hypholoma uda.* On subsequent evaluation, the last two were deemed of little value.



F–397261

FIGURE 55.—Jack pine (2–0) seedlings showing effect of mycorrhizal soil and acidification treatment. Trees on the right received one-fourth ounce sulfuric acid, 1 pound of mycorrhizal soil, and one-fourth ounce of 15–30–15 fertilizer per square foot of seedbed. (One-inch squares are in background.)

or an established nursery, or the use of leaf mold and surface soil from a shelterbelt of pine or spruce. It will require at least 1 or 2 bushels of mycorrhizal soil or leaf mold per 100 square feet of seedbed to obtain any semblance of uniform inoculation; in order to use this amount, the material must be kept moist in transit, an acid soil condition (pH around 6.0) at the new nursery site must be achieved or maintained, and the inoculum must be spread very uniformly and disked into the surface 2 inches, and then the soil must be watered.

The safest procedure (the one that will introduce the least disease and the fewest insect pests) would be to obtain the leaf mold and surface soil from a natural pine or spruce stand. However, these are sometimes so distant that the material must be obtained from a planted stand or shelterbelt. If soil that contains mycorrhizal fungi from old nurseries or distant localities is used to inoculate a new site, it should be clearly free of insects, diseases, and nematodes. However, moving of soil or plants from one nursery to another is not generally recommended as a means of transferring mycorrhizal fungi.

The introduction of pure cultures of mycorrhizal fungi requires more research before it can be recommended for large-scale operations.

Mycorrhizal fungi are capable of maintaining themselves in soils where the host plants are absent for several years (Rosendahl and Wilde 1942). At the Towner Nursery, fungi lasted very well without a coniferous host plant from 1943, when the nursery went out of production, until 1953, when it was reactivated without reinocultaion of the beds. Even the first crop of spruce and pine produced after the 10-year lapse appeared to be abundantly supplied with appropriate mycorrhizal fungi, and the 2–0 beds in 1954 were quite uniform and of good color. The presence of humus extends their ability to survive (Kelley 1930).

NURSERY PROTECTION

More seedlings are lost or injured from various causes while in the nursery and during distribution than later, when they are in the field. To avoid serious losses from nursery injuries, constant vigilance will be needed, since early discovery is quite as important as prompt treatment.

Protection of seedlings involves guarding against loss by four major factors: Weather, insects, mammals and birds, and diseases. Major sources of injury, as well as some of the minor ones, are described in this section. Some formulas for insecticide and fungicide sprays and for mouse bait are given in the Appendix. Also in the Appendix, under "Sources of Information on Nursery Problems," are suggestions on sources from which additional information on specific problems can be obtained.

METEOROLOGICAL FACTORS

The climate of the Plains is characterized by extremes. Chief among the characteristics influencing the production of coniferous stock is the persistent, rather high wind movement; the low precipitation in the northwest portion furthest removed from the Gulf of Mexico; and the extremely high temperatures which occur everywhere where moisture is lacking at midsummer. While the nurseryman has no control over heat, cold, rain, hail, and wind, he can diminish the effects of all these forces, except hail, by good soil management, timely irrigation, development of effective windbreaks, and other good nursery practices.

Wind

Wind adversely affects seedling production by (1) burying the seed and seedlings or blowing them out of the ground; (2) causing mechanical injury by sweeping along the ground particles of sand that cut the small seedlings near the ground line or that sandblast the tender foliage or cotyledons; (3) accelerating depletion of the soil moisture and making the even distribution of water difficult; and (4) intensifying the drying effect of high temperatures on plant tissue (Engstrom and Stoeckeler 1941). Older stock may be affected by desiccation of the tops, which results in foliage and bud damage and a less attractive appearance. Roots dry out faster if the wind is blowing during lifting operations.

The location of nurseries in naturally protected sites will reduce wind damage. Where this is not possible, protection must be provided by a system of windbreaks. For exterior belts, two to seven rows may be needed. For interior windbreaks, one to three rows should suffice.

The zone of intensive wind protection for good shelterbelts is usually about 10 tree heights. Trees in nurseries with supplemental water and high fertility levels will generally attain effective heights of 40 to 50 feet. The spacing between belts thus can be about 400 to 500 feet.

Nurseries with rather limited space may find it advisable to avoid using cottonwood, Siberian elm, and other species with widespread root systems. It may be better to use one to three rows of conifers in exterior belts and only snow fence for interior portions.

Species that may serve as host or brood trees for insects and mites or as sources of infection for diseases that attack trees being grown in the nursery should be avoided if possible. Eastern redcedar has carried over populations of red spider, with subsequent reinfestation of new seedlings in Nebraska nurseries; and white spruce has done the same in North Dakota. Scale insects and tip moths are examples of insects that may maintain populations on pine in windbreaks and thus infest seedling and transplant beds. Phomopsis blight of junipers may be transmitted from older trees in the nursery to new seedlings.

It is customary to place interior roads next to the windbreaks as much as possible since, even under irrigation, the 15- to 20-foot zone next to such windbreaks is not suitable for nursery stock production because of the sapping and shading effect of the trees. Biennial pruning of the roots during the dormant season will help reduce the sapping effect. The pruning is done 10 to 20 feet from the trees and to a depth of 2 to 2½ feet. It can be done with a root cutter, a chisel subsoiler, or a middlebuster plow modified as a root cutter.

One-row plantings of Siberian elm spaced about 4 feet apart have proved very effective at the Oakes Nursery (fig. 56). The east-west belts are about 175 to 200 feet apart, and the north-south belts are about 400 feet apart.

The presence of at least one or two rows of conifers, particularly a row of pine flanked by a row of another dense-growing species, in exterior or major windbreaks helps reduce wind erosion when broadleaf species are devoid of leaves (fig. 57). Nurseries laid out on the contour may benefit from interior windbreaks paralleling terraces and placed at intervals of about 100 to 200 feet (fig. 58).

Some nurseries use interior hedges of tall-growing shrubs or trimmed cedar. Some Canadian nurseries have trimmed hedges of Siberian peashrubs.

Most nurseries use some slat-wire snow fence placed on pipe supports under pipelines (fig. 59) to reduce sand movement in the interior of blocks. They are especially useful on new sites which have little or no protection by taller tree growth.

The use of annual plants such as sorghum, cane, sunflower, and Sudangrass as temporary windbreaks has been tried in many nurseries in the Plains region. They have not been effective in protecting seedlings because they are not tall enough during the critical period and they sap soil moisture needed by the seedlings in adjacent rows.

(PHOTO COURTESY OF THE NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE)

FIGURE 56.—Siberian elm shelterbelts at Oakes Nursery, Oakes, N. Dak.

F–475108

FIGURE 57.—This row of 18-year-old ponderosa pine in an exterior shelterbelt is already a substantially effective wind barrier both in summer and winter, Towner Nursery, Towner, N. Dak.

Nursery rows should run at right angles to the prevailing summer wind if the lay of the land permits. Successive rows of transplants will break up the sweep of the wind near the ground.

Heat

Extremely high air temperatures damage seedlings by heating the soil surface at the ground line to a lethal temperature or by causing the tops to transpire faster than their moisture supply from the soil can be replenished. The common occurrence of lesions on the stems of very young seedlings in the Bessey Nursery was early attributed to excessive heating of the surface soil (Hartley 1918).

Heat injury may appear as heat lesions on the stem at the ground line or as a burning of the leaves and succulent tops. Heat cankers have been noted to be more prevalent on seedlings in rows oriented east and west.

In Southern Plains nurseries, trees may be damaged

F–488076

FIGURE 58.—Interior single-row, 6-year-old hedges at the State Nursery, Norman, Okla. These are mostly oriental aborvitae (on right) placed on the downhill slope of each terrace. Multiflora rose (on left) and eastern redcedar were used in a few of the hedges.

F–320779

FIGURE 59.—Slat-wire fences not only protect the soil from blowing and the trees from wind injury but also trap snow. Note relative absence of snow on unprotected field in distance. Towner Nursery, Towner, N. Dak., April 1936.

by heat when hot temperatures and high winds occur in May while the plants are still succulent.

Shirley (1936), in a study of the relative resistance of 1- to 4-year-old conifers of four species to high lethal temperatures in a water bath and under high (85 percent) and low (15 percent) relative humidities, concluded that: (1) Resistance to excessive heat increases with increasing age and increasing size or mass of plant and tissue; (2) tops are more resistant than roots; (3) temperatures as high as 111.7° F., while not causing severe damage to tops in exposures of up to 5 hours, may kill the roots; and (4) there is little difference in the ability of red, white, and jack pine and white spruce to withstand heat. He also found that the external killing temperature for plant material of comparable size and age was higher in air than in water and higher in dry air than in moist air. Bates and Roeser (1924), working with ponderosa and lodgepole pines, Engelmann spruce, and Douglas-fir, also found that the resistance of all seedlings to excessive heat became slightly greater with aging and accompanying hardening of tissues and with an increase in the number of needles. Older plants stand heat better than first-year trees (Shirley 1936).

Beds of 1–0 ponderosa pine at Towner, N. Dak., were injured when the soil temperature at the surface reached 120° F. Baker (1929), in a study of the effect of unusually high temperatures on coniferous reproduction, found that 1- to 3-month-old seedlings of ponderosa pine and Sitka spruce were quickly killed by temperatures of 130°.

Observations by Roeser (1932) of approximate critical temperature maxima that ponderosa pine of different ages can endure may be useful to nurserymen in judging whether to irrigate:

Age in days	*Critical temperature in degrees F.*
58	122
71	133
110	136

He found Douglas-fir and Engelmann spruce were more sensitive to heat injury at 71 days of age than were ponderosa pine or lodgepole pine.

Nursery techniques that will produce sturdy woody stems as early in the season as possible are a logical solution to this problem of heat injury. Older seedlings and transplants shade the soil and reduce the surface soil temperatures.

Irrigation by overhead sprinklers and shading help reduce the damage from heat. In 1936, considerable heat injury was observed on the southwest side of 30- to 50-day-old ponderosa pine seedlings at the Towner Nursery when the soil surface temperatures reached 120° F. or higher. On hot days, the high soil surface temperatures, after one-half hour of watering started around noon, were promptly reduced from a critical temperature of about 125° to below 100° and were held under 120° for 4 hours or longer (fig. 60) (U.S. Forest Serv. Lake States Forest Expt. Sta. 1937).

Adequate stand density may be an important factor in reducing heat losses since seedlings growing close together protect and shade each other. However, other factors besides heat protection must be considered before a decision is made on the number of seedlings to be grown per square foot.

Frost and Winter Damage

Seedbeds generally need to be protected overwinter. In the Northern and Central Plains especially, windburn, winter injury, frost heaving, sudden extreme drops in temperature, and spring and fall frosts are hazards to the seedlings.

In the North it is risky to have succulent trees in the nursery later than September 10. Therefore, well-developed plants must be produced by mid-August in North Dakota and by September 1 in Nebraska. Irrigation and cultivation should be discontinued at that time.

Seedling nutrition also is important. Kopitke (1941) found that a balanced supply of nutrients, and especially an adequate amount of potash, appeared to be the most important prerequisite for the production of frost-resistant stock. Maximum benefits were obtained when the concentration of potash was adequate to produce a vigorous seedling at the very beginning of development.

Pines and junipers in the Dakotas are likely to have a high percentage of their foliage browned by winter injury, even in second-year beds. Sometimes transplants are affected. The browning is due to loss of moisture from the needles while the ground is frozen and the roots are unable to supply moisture. This injury may occur in March or early April on bright, sunny days with high winds, low humidity, and air temperatures in the 41° to 60° F. range (Walker and Kerr 1954).

Mulches have been used extensively in conifer production in the Plains. Many different materials have been used, including snow fence, shade frames, rolled burlap, hay, and plastic sheeting.

A 2- or 3-inch layer of clean straw or marsh hay may be applied shortly before the soil freezes. Coverage should include the paths as well as the seedbeds and transplant beds. The mulch should be left on until March or April.

Sawdust is another mulch that has been tried. A layer 1¼ inches deep was effective in one experiment (Farnsworth et al. 1956.) Sawdust has been used extensively only in the Oklahoma nurseries, and there only as a thin covering over recently sown conifers, especially fall-seeded eastern redcedar.

Paper mulches have been tried experimentally, but do not appear to be competitive in cost with other materials (Robbins 1932).

Snow fence rolled out on the bedboards has given effective protection. Mulch may or may not be used under it.

All beds should be wetted for a few days before covering is applied.

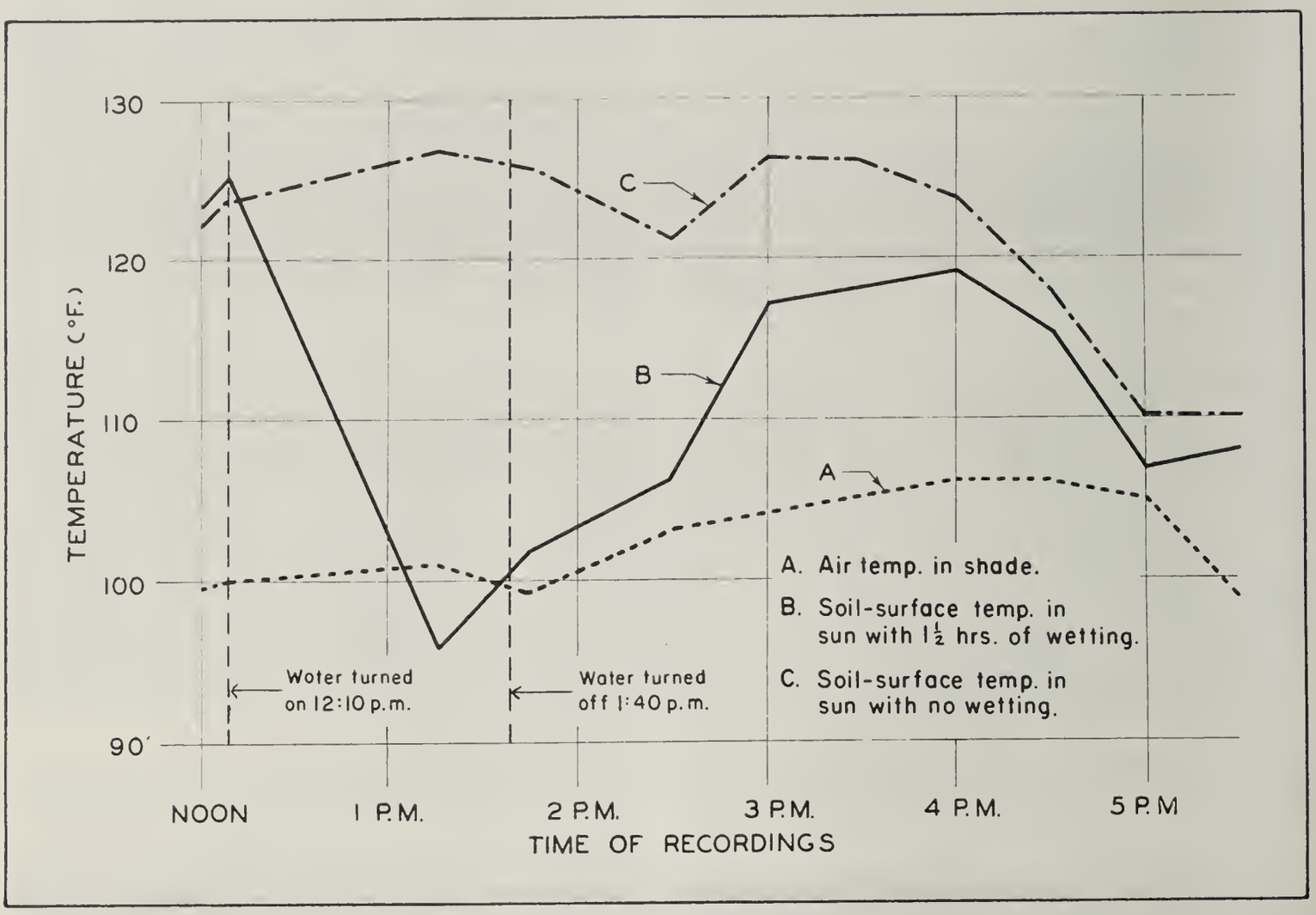


FIGURE 60.—Effect of watering on soil-surface temperatures: *A*, Air temperatures in shade; *B*, soil-surface temperatures in sun with 1½ hours of wetting; *C*, soil-surface temperatures in sun with no wetting. Towner Nursery, Towner, N. Dak.

As mentioned earlier, snow fences erected on every pipeline or on every second line aid in trapping snow within the nursery and afford some protection by keeping the trees covered with more snow and for a longer period in the spring. This practice is especially useful on transplant beds; however, it does not distribute the snow as uniformly as is desirable.

Frost heaving is a problem in northern nurseries. It occurs during open winters with little snow cover and in early spring when the seedlings are emerging. Often 1–0 stock is frost heaved partly or entirely out of the ground. Eastern redcedar and spruce are particularly susceptible. Removing the mulch at a date later than normal will reduce the damage from this source.

Fall-sown eastern redcedar seed germinates early in May in central Nebraska. When freezing temperatures may occur after germination, mulching with clean straw or marsh hay and sprinkling have been used to prevent frost.

Sometimes after overwinter mulches have been removed in the spring, a severe frost, with temperatures between 18° and 28° F., may be predicted. The trees may then be protected by rolling out snow fence on the bedboards or by rolling burlap directly on top of the half-shade or directly on top of 1-year-old frost-sensitive seedlings such as spruce or fir. Irrigation with an overhead sprinkler system also offers some protection. The sprinklers are turned on the beds of sensitive species as soon as, or slightly before, the temperature drops to 32° and are kept on until the temperature rises. In some instances a sheet of ice formed between the trees, but on melting, little or no damage had occurred from freezing (Stoeckeler and Jones 1957). Most of the effectiveness of this method in preventing frost damage is lost when the temperature reaches below 25°.

NURSERY INSECTS AND MITES

Insects and mites may cause serious damage in nurseries. Frequent checks are necessary to detect injuries in the early stages so that losses are reduced and control measures can be applied promptly. Damage may be to the roots or tops or both of seedling and transplant stock. Some insects, such as white grubs,

are common nursery pests on both conifers and hardwoods in the Plains (Wygant 1936). Others, such as the Nantucket pine tip moth, attack only conifers and are found only in certain areas. The range of some insects is believed to have been increased through the distribution of infested nursery stock (Craighead 1950, Graham 1939).

Fortunately, in recent years an improved general knowledge of insects and their life cycles has made possible the efficient use of newly developed insecticides. The stomach insecticides are used for killing top feeders, especially larvae of moths, beetles, and sawflies. The arsenicals, particularly lead arsenate, are the most important inorganic stomach insecticides. Some organic insecticides, such as derris, pyrethrum, and tobacco products, are stomach poisons. The newer organic chemicals, such as DDT, chlordane, and benzene hexachloride, act as both stomach poisons and contact insecticides. Contact insecticides, which are used chiefly to control sucking insects, also include nicotine sulfate, pyrethrum, lime sulfur, sulfur dust, oils, and oil emulsions.

White Grubs

Larvae of the May beetle and related genera (*Phyllophaga spp.*) eat the roots of coniferous seedlings, causing death or reducing growth. Occasionally the tender stems of newly germinated seedlings are consumed.

The life cycle of the insect, 2 to 5 years, varies by species and latitude (Craighead 1950). For the more injurious species in South Dakota and Nebraska, it is 3 years. The adult beetles eat the foliage of deciduous trees, and the females oviposit in the soil near the trees. Most of the damage occurs during the second year of development, when the grubs are feeding heavily and larval growth is rapid. These larvae are white and have brown heads, stout, curved bodies, and six prominent legs.

At the Bessey Nursery in 1930, a grub population of one to eight per square foot caused losses of as much as 50 percent of transplant ponderosa pine, with some damage to jack and red pine. Losses have also occurred in 1–0 eastern redcedar beds. Severe damage to pine transplants reportedly occurred in a nursery in southeastern Manitoba (Prentice and Hildahl 1959).

Before seeding, white grub control can be obtained in nurseries through the application of 8 pounds of chlordane per acre. It is applied in the form of 80 pounds of 10-percent dust. The insecticide is mixed immediately with the soil to an 8-inch depth with a rotarytiller or disk (Speers and Schmiege 1961). A maintenance dosage of 1 to 1½ pounds per acre will be needed every 2 years. Dieldrin, applied at the rate of 1½ pounds per acre and then at one-half pound every 2 years, may be substituted for chlordane. Excellent control has been reported following fumigation with methyl bromide gas at the rate of 2 pounds per 100 square feet (Hill 1955).

Areas with trees receive an application of chlordane emulsion, applied at a dosage of 1 part in 200 parts of water, and then sprinkling for 3 to 4 hours to get the material into the soil. In western Kansas white grubs in potted evergreens also have been controlled by application of chlordane.[20]

Nantucket Pine Tip Moth

The Nantucket pine tip moth (*Rhyacionia frustrana* (Comst.)) is a pest of most species of two- and three-needled pines occurring throughout the East and through the Central States to Texas (Craighead 1950). A variety (*R. frustrana bushnelli* (Busck)) is more common in the Plains area of Minnesota, the Dakotas, and Nebraska. The larvae mine the shoots and buds of nursery stock and older trees. One or two larvae will hollow out only the buds or apex of the new shoot, but where they are numerous, the entire shoot may be riddled with their burrows, and deformation and stunting of the trees may result.

The larvae are yellow to pale brown and have brown heads. They are nearly one-half inch long when fully grown. Winter is passed in the pupal stage. The Nantucket pine tip moth pupates within the injured twig tip, and the form *bushnelli,* in the litter on the ground (Craighead 1950). One generation is produced each year in the Black Hills and in North Dakota, two occur in Nebraska (Wygant 1936), and up to four are produced in Oklahoma and Texas (Afanasiev and Fenton 1947, Craighead 1950).

The form *bushnelli* has long been a pest at the Bessey Nursery in Nebraska; infested seedlings were reported as early as 1911 (Swenk 1927). It was almost certainly introduced to this grassland area on infested stock (Graham and Baumhofer 1927). Ponderosa pine is most severely attacked, followed by red, jack, Scotch, and Austrian pines, in order of decreasing susceptibility.

In Oklahoma the native shortleaf and loblolly pines are heavily infested. Also attacked are Japanese red, Austrian, Scotch, Japanese black, and ponderosa pines, in descending order of their attractiveness to *bushnelli.* The larvae are thought to prefer those species with thin, soft, flexible needles (Afanasiev and Ashdown 1951).

The danger of introducing the pine tip moth into nurseries and plantings on infested stock cannot be overemphasized. For control of the Nantucket pine tip moth on planting stock, Hall (1936) recommends that all seedbeds and transplants be checked in the fall for evidence of the insect and that all infested tips or buds be removed and destroyed. Fumigation of stock moving into or out of the nursery will kill eggs, larvae, and pupae. A commonly used control measure is to dip infested stock before shipment in a miscible oil, alone or mixed with nicotine.

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[20] Personal communication with Melvin Dimitt, Nurseryman, Garden City, Kans.

Beds where the insect is present should be sprayed with DDT.

Red Spiders

Various species of red spiders attack evergreens growing on the Plains. Nursery stock may become infested if it is grown close to trees with mite populations. Red spiders are acarinids and not insects but are considered here because control measures for these pests are similar to those used against certain insects. Although small, their number increases rapidly, particularly when the weather is hot and dry. They suck the juices of plants, causing premature yellowing and falling of the foliage.

The adults hibernate in the soil or in other protected places and begin laying their eggs in early summer. Several generations develop during the summer. Their irregular webs spun over the leaves and stems of plants help protect the spiders from wind and rain but also signal their presence.

The two-spotted spider mite *Tetranychus telarius* (L.) is the most common and injurious species (Craighead 1950); it has attacked juniper, spruce, and pine in Plains nurseries. It was particularly troublesome on juniper species at the Bessey Nursery prior to the removal of eastern redcedar windbreaks in 1958. Ponderosa pine seedlings and transplants are also attacked in this nursery.

The spruce spider mite *Oligonychus ununguis* (Jacobi) is a pest of ornamental evergreens and coniferous forest trees and has been reported from North Dakota (Goodfellow and Colberg 1958) and on the Canadian prairie (DeGryse 1924). Favorite hosts include *Picea, Juniperus,* and *Cupressus* (Pritchard and Baker 1955). Nonphosphate acaricides, including aramite, Dimite, chlorobenzilate,[21] and others, have proven highly effective in controlling infestations. These materials have the advantage of not being harmful to insects, and the various species of spider mites apparently have not acquired immunity to them (Johnson 1958).

The materials are mixed with water and applied at the recommended dosages from the ground by garden-type or commercial spraying equipment. The foliage should be wetted thoroughly, and applications should be repeated when injury is evident or increasing.

Wireworms

Wireworms are long, cylindrical, brown, hard-shelled "worms," usually with well-developed legs, that feed in the soil on small roots and other plant materials. They are the larvae of the click beetles (Elateridae). Most species are crop feeders. The roots of newly germinated seedlings of eastern redcedar have been attacked at the Bessey Nursery, but damage was slight, as new roots developed.

Plowing, harrowing, disking, and cultivation used in the nursery for various purposes tend to reduce populations. Use of soil fumigants such as ethylene dibromide has given good control of wireworms (Keen 1952).

Cutworms

Cutworms appear occasionally on conifers in Plains nurseries; they damage the young trees considerably by feeding on the foliage, tender roots, or stems, and by clipping off seedlings at the ground line (Craighead 1950). They are the larvae of night-flying moths of the family Phalaenidae, commonly referred to as millers. They have been reported in 1–0 seedbeds of the Monument Nursery in Colorado [22] and the Savenac Nursery in Montana.[23] Slight damage has been reported at the Bessey Nursery.[24]

Control can be obtained by spreading commercially prepared baits over the beds in the late afternoon. Dusts of DDT or chlordane also are effective.

Grasshoppers

Grasshoppers are primarily pests of agricultural crops, but they may strip the foliage from conifer nursery stock, particularly during outbreaks and drought years. Grasshoppers can be controlled with sprays, dusts, or baits.

Sprays may be composed of one of the following active ingredients, in the following amounts per acre: Aldrin, 1½ to 2 ounces; chlordane, one-half to 1 pound; or Toxaphene, 1 to 1½ pounds (Parker and Cowan 1953). The lower dosages are used on young grasshoppers or in areas where the vegetation is short or sparse. A buffer strip 100 yards wide outside the nursery as well as the nursery stock should be treated. Treatment is started when the young grasshoppers begin to move from their places of hatching.

Other chemicals used in grasshopper control are methoxychlor, Dieldrin, parathion, and dilan, but these should not be used unless specifically recommended by county agents or the State entomologist.

In 1928, in the coniferous plantations adjacent to the Bessey Nursery, grasshopper damage was heaviest on Scotch and Austrian pine foliage and stems; in jack and ponderosa pine, the stems were preferred to the foliage; ponderosa pines seldom were chewed.[25] No damage to the junipers was reported.

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[21] To avoid using technical names, common names are given as listed by the Committee on Insecticide Terminology of the Entomological Society of America for use in the Journal of Economic Entomology. (Haller, H. L., 1957. Common names of insecticides. Jour. Econ. Ent. 50: 226–228).

[22] U.S. Forest Service. 1931 Annual Planting Report, Region 2, Denver, Colo.

[23] U.S. Forest Service. 1937 Annual Nursery Report, Savenac Nursery, Region 1, Missoula, Mont.

[24] U.S. Forest Service. 1937 and 1951 Fiscal Year Annual Nursery Reports, Bessey Nursery, Region 2, Denver, Colo.

[25] U.S. Forest Service. Calendar Year 1928 Annual Planting Report, Nebraska National Forest, Region 2, Denver, Colo.

In 1949, grasshoppers were in the Bessey Nursery, but they confined their eating mainly to the green manure crops.[26]

NURSERY DISEASES

Disease control, according to Hartley (1935a), is largely a matter of prevention by proper selection of nursery sites and species and by attention to soil condition, stand density, and sanitation. However, even if all reasonable precautions are taken, some diseases are almost certain to be a problem at some time in every nursery.

Damping-off

Damping-off is a generalized term applied to the killing by fungi of very young seedlings just before or after they emerge from the ground. It is common throughout Plains nurseries and is the strongest deterrent to the growing of conifers other than the junipers from seed in this region. Losses from this cause are sporadic and are slight to complete. Often this situation introduces great uncertainty into nursery operations by upsetting stock production schedules, influencing stand densities, and causing wastage of seed.

Damping-off affects the seedlings of most conifers; only the genera *Juniperus, Cupressus, Thuja,* and *Chamaecyparis* are resistant to it (Hartley 1921). Heavy losses to pine and spruce beds have occurred in the Canadian prairie provinces, the Dakotas, and elsewhere. In 1933, at the Bessey Nursery in Nebraska, ponderosa pine suffered postemergent losses up to 50 percent, and the red pine was almost completely destroyed.[27]

Hartley (1935a) identified various species of the genera *Pythium, Rhizoctonia,* and *Fusarium* as causal organisms of damping-off. Pathogenic tests on seeds of white spruce, blue spruce, Scotch pine, and caragana at Indian Head, Saskatchewan, showed the same genera but indicated that *Rhizoctonia* was the most virulent isolate (Cram 1956b). Thomas (1953), in a preliminary report, suggests that *Pythium* isolates were the main cause of damping-off losses in conifers in Saskatchewan.

To minimize damping-off losses, seedbeds should be located on sandy soils with good internal drainage. Heavy or excessively wet soils should be avoided.

Damping-off is increased in severity by the use of poorly rotted manures, dried blood, or materials that increase the carbon-nitrogen ratio of the soil (Hartley 1935b). Incorporation of certain cover or soil improvement crops into the soil prior to seeding may have the same effect. In general, legumes, especially sweetclover and redclover, increase damping-off. In central Illinois, 64 percent fewer red pine seedlings were produced in seedbeds where a green manure crop of cowpeas or soybeans with Sudangrass had been plowed under while green than in seedbeds with no cover crop (Wycoff 1952). Fumigating the soil or removing the crop (instead of plowing it under) are suggested methods of reducing losses from damping-off where new seedings follow these crops by necessity at an interval of less than 4 to 6 weeks. The possibility of damping-off is also increased by the addition of other materials that decrease acidity, such as lime, limy sand, wood ashes, or nitrates, and the use of irrigation water that has a hardness of over 100 p.p.m. as $CaCO_3$ or 125 p.p.m. as a bicarbonate (Davis et al. 1942). Damping-off fungi may be introduced in infected nursery stock from distant nurseries or in soil brought into the nursery on machinery.

There are three principal methods of controlling or reducing the incidence of damping-off. They are soil acidification, soil sterilization or fumigation, and the application of fungicides to the seed or soil.

In Plains nurseries, soil acidification is commonly used since it has the added advantage of counteracting the tendency toward soil alkalinity where alkaline waters are applied in irrigation. The amount of acidifying material to apply depends largely on soil texture and its pH before treatment, but it usually consists of one-sixteenth to one-eighth fluid ounce of concentrated sulfuric acid per square foot. The acid is diluted in water to a 2-percent solution by volume. It is applied immediately after the seed is sown, and the beds are then watered. Sulfuric acid has been most effective in damping-off control of the acidifying materials tested, including sulfur.

Other materials, such as aluminum sulfate, ferrous sulfate, and phosphoric acid, are also useful for controlling pre-emergence and ordinary damping-off loss. At the Bessey Nursery, aluminum sulfate cost less than ferrous sulfate and produced superior results. Here, postemergence applications of one-half ounce of aluminum sulfate in water per square foot has successfully curbed early summer damping-off. Good control has been obtained with an annual application of 15 grams of aluminum sulfate per square food of seedbed; it is broadcasted dry and watered in.[28]

Deep treatment with one-fourth to one-half avoirdupois ounce of sulfur per square foot, mixed into the soil to a depth of 6 or 8 inches, has value as a damping-off control and will lower the pH of the soil for a longer time than other acidification treatments (Stoeckeler and Arneman 1960). To avoid acid injury, the sulfur should be well pulverized and applied for several warm months or a full year before seeding.

Fumigating nursery seedbeds with gaseous methyl bromide reduces damping-off losses. Side benefits in-

[26] U.S. Forest Service. Fiscal Year 1950 Annual Nursery Report, Bessey Nursery, Region 2, Denver, Colo.

[27] U.S. Forest Service. Calendar Year 1933 Annual Nursery Report, Bessey Nursery, Region 2, Denver, Colo.

[28] Personal communication with E. W. Johnson, Agricultural Research Service Field Station, Woodward, Okla.

clude the control of weeds, nematodes, insects, and other soil-borne plant parasites. Standard dosages for damping-off control are 1 to 2 pounds per 100 square feet of soil surface. A machine used at the Chittenden Nursery, Wellston, Mich., applies the vaporized fumigant rapidly under a polyethylene cover laid directly over the seedbed (Clifford 1959). Cockerill (1957), testing methyl bromide in Ontario, found that it reduced pre-emergence losses and resulted in higher emergence of seedlings, but failed to control later damping-off.

Another means of soil sterilization is the use of one-fourth fluid ounce of commercial 40–percent formaldehyde per pint of water per square foot of seedbed. This solution is applied 7 to 10 days before seeding, and the soil is then heavily watered (Davis *et al.* 1942). Seven days is sufficient in warm weather or on soils with abundant humus, while 10 days is necessary in cold, damp weather or on heavier soils.

Pelletizing seed with a fungicide has given better protection than seed dusts. Furthermore, bird and animal repellents can be incorporated in the pelletizing material, and a larger and more uniform seed is produced for sowing. Mony (1958) reported control of early damping-off at the Vallonia Nursery, Vallonia, Ind. He used a fungicide-insecticide pelletized mixture consisting of equal parts of 75–percent thiram, 50–percent captan, and 50–percent W. endrin. He discusses equipment, materials, and methods used in pelletizing.

In Southern nurseries, seed treatments with fungicidal dusts have given virtually no control of damping-off of southern pines or other pines (Wakeley 1954).

Soil dusts applied before seeding show promise of providing more prolonged protection than that secured with seed dusts. Tests of several soil dusts (Strong 1952) indicated that the following were the most promising in Michigan: Thiram (wettable tetramethyl thiuram disulfide), experimental fungicide 5400, 31 parts of Ceresan M (ethyl mercury p-toluane sulfonanilide) plus 1 part of potassium iodide, and maneb (manganese ethylene bisdithiocarbamate). These fungicides were mixed with soil and applied dry with commercial fertilizers at the rate of 150 pounds of fungicide per acre. The beds were then rototilled to a depth of 5 inches. Treatment should be made 3 days before seeding; if rain occurs, seeding should be postponed for 6 days.

In Saskatchewan, soil drenches with Thiram (75 percent) or captan (75 percent) gave very good control of *Rhizoctonia solani* without damage to seedlings in a test on blue spruce, Scotch pine, and caragana (Cram and Vaartaja 1957). The first application, made prior to seeding, was fairly heavy (0.6 gram thiram per square foot); later, postemergent light applications were made at 1- or 2-week intervals (0.1 gram). These materials are particularly useful since they can be used to control postemergent damping-off in seedbeds where preseeding control measures have been neglected or proven inadequate.

Indirect methods of controlling damping-off include sowing at lower seedbed densities, covering the seed with clean nonalkaline sand, and removing half-shade or seedbed covers during prolonged damp weather.

Cedar Blight

Cedar blight is the most damaging disease affecting junipers. It occurs wherever eastern redcedar is produced and has caused heavy losses in Plains nurseries from North Dakota to Texas. The causal organism, *Phomopsis juniperovora,* invades the leaves and small stems, particularly those of the new growth. The foliage turns brown and the stem dries out (Baxter 1952). The tips die back and usually the small trees die. Spores are produced from small, dark fruiting bodies or pycnidia in the stems and needles of the infected trees. Under moist or humid conditions, *Phomopsis* spores are readily disseminated and infect other plants (Davis et al. 1942). Seedlings and transplants are subject to attack throughout the growing season.

A number of nurseries have been contaminated by the introduction of blighted cedar as transplants. There is a little evidence that contamination is possible by spore dissemination from nearby infected plantings. The blight in native redcedar in eastern Nebraska was considered the source of infection in a nearby nursery (Davis and Latham 1939). Once the disease has been introduced into a nursery, it is practically impossible to eradicate, and a continuing program of control is required as long as junipers are produced. Blight-free redcedar was produced at the Bessey Nursery for more than 40 years before the blight appeared in 1956, supposedly from infected planting stock.

Eastern redcedar, Rocky Mountain juniper, and their horticultural varieties are particularly susceptible, but other junipers and Arizona cypress are also attacked. Rocky Mountain juniper has been damaged less than eastern redcedar, probably because of its slower growth. At Manhattan, Kans., losses of eastern redcedar during a 3-year period averaged five times greater than those of Rocky Mountain juniper.[29] In the Prairie States Forestry Project Nursery at Fremont, Nebr., Rocky Mountain juniper was much more resistant to blight than eastern redcedar.[30]

Caroselli (1957) reported that WK–34 gave good control of *Phomopsis* blight when applied at 2- to 3-week intervals to 1- or 2-year-old seedlings at the rate of 1.2 ounces per 10 gallons of water. This spray contained 12 p.p.m. of cycloheximide (an antibiotic) and 675 p.p.m. of pentachloronitro benzene.

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[29] Slagg, C. M., and Wright, Ernest. *Phomopsis* blight of eastern redcedar and its control. 1943. Unpublished report on file at the Lincoln Field Station, Lincoln, Nebr., Rocky Mountain Forest and Range Expt. Sta., U.S. Forest Serv., Fort Collins, Colo.

[30] Personal communication with S. S. Burton, formerly Woodland Conservationist, Soil Conservation Service, Lincoln, Nebr.

Excellent control has also been obtained by the use of Puratized Agricultural spray (phenyl mercury compound) at the Oklahoma State Nursery at Norman. Sprays were applied at weekly intervals or more frequently if needed.

Spraying should be part of the regular nursery operation and should include all seedlings and transplants. Sprays should be applied every 7 to 10 days throughout the growing season. Twice-weekly applications may be necessary during moist, cool weather (Hodges 1962).

Rusts

Native rust-induced galls are widely distributed on two- and three-needled pines and to a lesser extent on junipers. The rusts considered here include only those fungi that develop on living leaves, stems, or branches without immediately killing them. Infected planting stock, however, may die after field planting.

The western gall rust, *Peridermium harknessii,* occurs in the West and has been observed in Prairie-Plains nurseries (Boyce 1961, Davis et al. 1942). Ponderosa and lodgepole pines are particularly susceptible. A ball-shaped gall is formed on the stem. The aeciospores can cause pine-to-pine infection (Meinecke 1929); hence, control cannot be effected by eliminating the alternate hosts, which may be paintbrush, louse-wort, owlclover, or birdbeak. Infected stock should be eliminated by grading.

The southern fusiform rust is caused by *Cronartium fusiforme.* Limited to the Southern States, it attacks a number of hard pines, including shortleaf and loblolly. Infected seedlings have spindle-shaped stem swellings. Control requires weekly spraying with ferbam, ziram, or zineb prior to infection (Foster 1959). All seedling tissue must be completely covered.

The eastern gall rust (*Cronartium cerebrum*) ranges eastward from the Prairie-Plains and is most abundant in the Southen States (Boyce 1961). Jack pine and shortleaf pine are favorite hosts. Oak is the alternate host. Control measures are similar to those recommended for the southern fusiform rust.

Large transplants or large ornamental stock of eastern redcedar, Rocky Mountain juniper, and other junipers are subject to cedar-apple rust (*Gymnosporangium juniperi-virginianae*). Round galls, 1 or more inches in diameter, are produced, but damage to the susceptible conifers is usually light. Control is obtained by spraying the junipers with a general purpose fruit spray containing ferbam or zineb fungicides at the rate of 1 to 1½ level tablespoons of wettable powder per gallon of water. These fungicides should be applied at 7- to 10-day intervals from late July to early September. Another effective spray is Elgetol, formulated at the rate of 1 gallon per 100 gallons of water and applied when the telial horns are small.

Antibiotics show great promise for providing effective control of rust diseases in nurseries, but detailed application methods are still to be developed.

Nematodes

Nematodes are tiny, threadlike, soil-inhabiting roundworms that feed on the roots of trees, especially small seedlings. They weaken the trees and may also provide entry courts for root rot fungi. The typical symptoms of nematode injury (Hodges 1962) are a general decline, stunting, and chlorosis of the seedlings. The control of nematodes in nurseries is a necessity in many areas of the country. Their control in Prairie-Plains nurseries will assume greater importance when the damage they cause is recognized and diagnosed correctly.

The root-lesion nematode has been recovered from the roots of eastern redcedar at Halsey, Nebr. (Caveness 1957), but not from those of ponderosa or Austrian pine. Stock of 1–0 and 1–1 age class was affected. After the roots of the 1–0 stock were infected at varying depths, the plants showed slightly offcolor foliage and reduced growth, and some mortality resulted.

The nematodes may be eliminated by treating the soil with methyl bromide gas at the rate of 1½ to 2 pounds per 100 square feet, ethylene dibromide at 3 to 6 gallons (85 percent EDB) per acre, or chloropicrin at 3 to 5 cubic centimeters per cubic foot of soil (Munnecke 1957). At the Bessey Nursery use of 1 pound of methyl bromide gas per 100 square feet gave good control of the root-lesion nematode.[31]

The manufacturer's directions on the method of treatment should be followed.

Dieback

Pine twig blight is a dieback of the current season's growth of hard pines caused by the fungus *Diplodia pinea* (Desm.) Kickx. Severe damage to seedlings of Austrian pine has been reported from a Kansas nursery by Slagg and Wright (1942). They also reported (1943) considerable damage from this blight in Southern Plains nurseries on Austrian and ponderosa pines, pinyon, and Douglas-fir.

Root Rots

The *Phymatotrichum* root rot has not been reported from nurseries, but it may become a problem there since it occurs in Oklahoma, Texas, and other parts of the Southwest where shelterbelt plantings are important. Both conifers and hardwoods are attacked, but eastern redcedar and Rocky Mountain juniper have a high resistance to the disease (Wright and Wells 1948). Based on 6 years of fieldplanting tests in Oklahoma and Texas, ponderosa and loblolly pines were susceptible and not recommended for use, while Austrian pine was less susceptible and considered capable of surviving on the more sandy soils.

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[31] Personal communication with Glenn Peterson, Rocky Mountain Forest and Range Experiment Station, Lincoln, Nebr.

MAMMALS AND BIRDS

Practically all nurseries are situated so that a fence is necessary to exclude domestic livestock or the larger wild animals such as deer. Some nurseries use woven wire fence or slat-wire snow fence, which will also exclude dogs or even rabbits. The intensity of protection used will depend entirely on the local situation.

If deer are a problem, a fence at least 10 feet high is necessary. At the Bessey Nursery extensive damage to seedlings by deer necessitated fencing and later live trapping when ordinary cattle guards failed to exclude deer at road entrances. In 1945, an estimated one million jack, Scotch, and Austrian pine seedlings were nipped and trampled by deer. The preferred species was eastern redcedar, followed by jack pine. Rocky Mountain juniper and Austrian pine were browsed to a lesser extent. Winter cover crops feed the deer in years of low animal population but attract additional animals to the nursery.

Jackrabbits, cottontail rabbits, and snowshoe hares may damage Plains nurseries. It is difficult to maintain a fence high and tight enough to exclude rabbits because they may come in over snowdrifts or get through under the wire. Occasional checking is necessary to determine whether rabbits have gained entrance and are doing damage by cutting off the tips of the seedlings. Cover crops may be eaten in preference to trees. If present, rabbits can be eliminated by snaring, trapping, or shooting.

Pocket gophers (*Geomys* and *Thomomys*) occasionally cut tree roots and smother seedlings under mounds in nurseries. They live almost exclusively in the ground, pushing out the soil to form troublesome mounds as they excavate their tunnels 4 to 8 inches below the surface. Effective controls include the use of regular pocket gopher traps or the placement of poisoned bait in the runways. Two or three pieces of diced fresh carrots or similar vegetable, dusted with strychnine alkaloid, at the rate of one-fourth ounce of powder to 4 quarts of carrots, should be put in several places in each burrow system. In replugging the placement holes, care should be taken to avoid covering the bait. Pocket gopher control should extend nearly one-fourth mile beyond the nursery since migration is sometimes extensive.

Many species of white-footed mice (*Peromyscus* spp.) may eat the seed of conifers as well as that of hardwoods. The meadow mouse (*Microtus*) eats seeds, and the pine vole (*Pitymys*), in an area from eastern Kansas south, may cut off small seedlings. Kangaroo rats (*Dipodomys*) have eaten pine seed in Nebraska nurseries.

Straw mulches used on seedbeds over the winter are especially attractive to mice and other rodents. Populations can be kept down by eliminating weeds and grass in fence rows. Hardware-cloth screens placed on bedboards also are used to protect the beds. Mice can be trapped easily with ordinary snap traps that are baited with peanut butter, an apple, a vegetable, or oatmeal, and placed in runways or near entrances of burrows.

The use of poisoned baits is probably the cheapest and most effective way of eliminating mice and some of the other seed-eating rodents, such as ground squirrels.

The principal poisons used are strychnine alkaloid and zinc phosphide. Poisoned grain may be mixed with mulch as it is applied to fall-sown beds, or it may be placed at bait stations at 100-foot intervals. The stations are staggered somewhat where bedboards tend to confine and channelize rodent movement. Outside the nursery, bait should be placed along the fence and in a bordering zone extending about 200 feet from the fence. In this zone, especially if it is grassy, bait should be spaced as close as 30 feet apart, in four lines paralleling the fence at intervals of about 50 feet. Commonly the bait is placed in small tin cans laid on their sides. Thus protected, the bait will remain effective for a longer time, and birds cannot reach it. *Do not place bait where livestock will have access to it.*

Moles damage new seedlings and 1–0 seedbeds by loosening the ground with their slightly raised runways. The runways also expose the seed or bury it too deeply. Moles may cut tree roots in a manner similar to that used by pocket gophers. These animals must be removed from the seedbeds as well as a small surrounding area. Mole traps and poison baits are effective.

Nurserymen with rodent problems may wish to write to the Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C., for the address of the nearest poison-bait distribution center. Prepared baits are available at such centers at cost. An alternative to the purchase of prepared baits is to use one of several formulas recommended by the Fish and Wildlife Service (Garlough and Spencer 1944) and to prepare the bait at the nursery. Two poison-bait formulas for mice are given in the Appendix on page 89.

Seed-eating birds may be a serious problem in conifer nurseries, particularly in years when the peak of the spring migration coincides with seedling emergence. They not only scratch out the seed and eat it, but also they nip the tops of the seedlings after they have emerged from the soil but still retain the seedcoats. A more localized form of damage is debudding of Austrian pine seedlings by sharp-tailed grouse (*Pedioecetes phasianellus*) during the winter.

Birds can be excluded by hardware-cloth screens placed over all seedbeds or those of the most susceptible species (fig. 61). At the Bessey Nursery fall-sown beds of juniper and Austrian pine are screened. More birds take the smaller seed of Austrian pine than that of ponderosa pine. Fall-sown juniper beds are damaged in early spring by the white-crowned sparrow (*Zonotrichia leucophrys*).

Repellents such as sublimated anthroquinone are being applied to seed in Southern nurseries (Mann and

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FIGURE 61.—Pettis screen section for seedbed protection from birds and rodents at Bessey Nursery, Halsey, Nebr. Each section is 4½ by 10 feet; ½-inch-mesh netting is used.

Kingsley 1958) and elsewhere (Abbott 1958) to protect seed before and during germination. Anthroquinone with a latex sticker should be applied at the rate of 15 pounds to 100 pounds of seed. Arasan, another bird repellent being used in Plains nurseries, also has rodent repellent qualities.

Another method of reducing bird damage is to vary the time of seed sowing. Fall sowing results in earlier germination, and in some localities the seedling emergence is completed by the time the main flight of certain species of migratory birds arrives. In other instances, spring sowing may be delayed until the main offenders have passed on their way north.

Some degree of control may be secured by systematic patrolling of the seedbeds in daylight during the critical germination period.

Shooting of the birds should be limited strictly to those species not protected by State or Federal law.

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APPENDIX

COMMON AND SCIENTIFIC NAMES OF TREES AND SHRUBS MENTIONED

Conifers

Arborvitae, oriental (Chinese)	*Thuja orientalis* L.
Cypress, Arizona	*Cupressus arizonica* Greene.
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco.
Fir, balsam	*Abies balsamea* (L.) Mill.
Fir, Siberian	*Abies sibirica* Ledeb.
Juniper, alligator	*Juniperus deppeana* Steud.
Juniper, Ashe	*J. ashei* Buchholz.
Juniper, common	*J. communis* L.
Juniper, oldfield common	*J. communis* var. *depressa* Pursh.
Juniper, one-seed	*J. monosperma* (Engelm.) Sarg.
Juniper, Pinchot	*J. pinchotii* Sudw.
Juniper, Rocky Mountain	*J. scopulorum* Sarg.
Juniper, Utah	*J. osteosperma* (Torr.) Little.
Larch, European	*Larix decidua* Mill.
Larch, Siberian	*L. sibirica* Ledeb.
Pine, Austrian	*Pinus nigra* Arnold.
Pine, Digger	*P. sabiniana* Dougl.
Pine, Italian stone	*P. pinea* L.
Pine, jack	*P. banksiana* Lamb.
Pine, Japanese black	*P. thunbergi* Parl.
Pine, Japanese red	*P. densiflora* Sieb & Zucc.
Pine, Jeffrey	*P. jeffreyi* grev. and Balf.
Pine, limber	*P. flexilis* James.
Pine, loblolly	*P. taeda* L.
Pine, lodgepole	*P. contorta* Dougl.
Pine, ponderosa	*P. ponderosa* Laws.
Pine, red	*P. resinosa* Ait.
Pine, Scotch	*P. sylvestris* L.
Pine, shortleaf	*P. echinata* Mill.
Pine, Swiss stone	*P. cembra* L.
Pine, Virginia	*P. virginiana* Mill.
Pine, western white	*P. monticola* Dougl.
Pinyon	*P. edulis* Engelm.
Redcedar, eastern	*Juniperus virginiana* L.
Spruce, blue	*Picea pungens* Engelm.
Spruce, Engelmann	*P. engelmannii* Parry.
Spruce, Siberian	*P. obovata* Ledeb.
Spruce, Sitka	*P. sitchensis* (Bong.) Carr.
Spruce, white (includes Black Hills)	*P. glauca* (Moench) Voss.
Tamarack	*Larix laricina* (Du Roi) K. Koch.

Broadleaves

Cottonwood, eastern	*Populus deltoides* Bartr.
Elm, Chinese	*Ulmus parvifolia* Jacq.
Elm, Siberian	*U. pumila* L.
Oak, bur	*Quercus macrocarpa* Michx.
Peashrub, Siberian	*Caragana arborescens* Lam.
Rose, Japanese	*Rosa multiflora* Thunb.

SAFETY RULES AND PRECAUTIONS FOR HANDLING, MIXING, AND APPLYING CHEMICALS

Most insecticides and fungicides and some other sprays and baits contain poisons injurious, if not deadly, to humans and livestock. Many act through the skin or lungs as well as through the digestive tract. In addition, some are flammable or explosive, or involve other hazards. Wakeley (1954) lists some general rules which, if properly enforced, should minimize accidents occurring when poisons and other hazardous materials are handled. They are as follows:

1. Plainly mark both temporary and permanent containers to show nature of contents (poisonous, flammable, etc.) and date of purchase (some chemicals change or deteriorate with age). Keep dangerous materials tightly closed (unless their nature requires venting); out of reach of children, irresponsible persons, livestock, and pets; and in an adequately ventilated storeroom, preferably locked.

2. When mixing or applying poisonous materials, be extremely careful to keep them out of the mouth, eyes, nose, and lungs, and away from tender parts of the body. Ordinarily, wear leather or paraffined-cloth gloves (rubber or plastic gloves must be used with certain chemicals), and always wear goggles, a respirator, or a combination of the two. If the manufacturer specifies, mix substance only in open shed or outdoors.

3. Prohibit smoking during the mixing or application of flammable or explosive substances.

4. Burn or bury empty packages and bags that have contained poisons. Bury unused or discarded materials. When mixing vessels, sprayers, etc., are washed after use of the more poisonous substances, empty washwater into a hole in the ground, and fill in the hole. Do not burn empty arsenical containers except in open air. (Addition by authors: Avoid breathing smoke or fumes from burning empty chemical containers.)

5. Always wash hands and face thoroughly after mixing or applying poisonous substances. After long exposure, bathe and change clothes. Wash the clothes after each day's spraying.

6. Be sure that no poisonous spray material can get into domestic or livestock water supplies.

7. If sulfuric acid must be diluted (as for acidifying soil to control damping-off), always pour the acid, which is the heavier liquid, into the water. Water poured into sulfuric acid spatters badly, with serious danger, especially to the eyes.

Only the most responsible and trustworthy personnel should be allowed to handle chemicals that are explosive, flammable, or toxic to humans. It is extremely important that the directions on the labels on insecticides, fungicides, or weed killers be carefully read and followed. Containers for chemicals that have been emptied should be stored in a safe place or destroyed. Surplus mixtures should be buried and covered with soil. They should not be poured into

streams or ponds where they may endanger human life, fish, or livestock.

Workers handling concentrated acid should be equipped with goggles, rubber gloves, and acidproof aprons. Once the acid is diluted to a 2-percent solution, it is not particularly hazardous to handle.

Workers should not breathe the fumes of chemicals, especially methyl bromide, allyl alcohol, and parathion (Frear 1959). In the manual application of methyl bromide, special injectors, as supplied or recommended by the manufacturer of the chemical, should be used. Masks or respirators should be worn when handling allyl alcohol, methyl bromide, Ferbam, and parathion.

Allyl alcohol, methyl bromide, chlordane, Ferbam, nicotine, and parathion should not be brought into contact with the skin. This precaution should also be observed when handling seedlings treated with such chemicals as Endrin and nicotine. These chemicals are used to repel rabbits after fieldplanting.

Some chemicals, such as carbon disulfide, are explosive. Others, such as chlorates and mineral spirits, are quite flammable. Ammonium nitrate (Moore 1960) and allyl alcohol are both explosive and flammable. Therefore, they must be stored in well-ventilated buildings well separated from warehouses and other buildings.

Certain insecticides are harmful to bees, which help pollinate many plants. If spraying with DDT is necessary, it should be done when the flowers are in the bud rather than the bloom stage. However, if the flowers are in bloom, toxaphene can be sprayed in the early morning or late evening.

Use of oil sprays in the summer is not recommended because the oil may injure the foliage or new growth of small nursery trees. In the dormant season, sprays should be thoroughly mixed or emulsified before application. Oil emulsions of more than 4 percent strength may damage trees. If oils or oil emulsions are used, tanks must, in most cases, be reasonably free of any lime sulfur residues, since these may break down the emulsion.

Many insecticides and fungicides tend to stain wood, painted surfaces, and stone. The stain damage caused by direct application or drift can be lessened by thoroughly wetting the object before and after an application.

Sprayers used for weed or brush killers, such as 2,4-D or 2,4,5-T, should not be used for spraying insecticides or fungicides in the nursery because minute residues of these chemicals may damage or kill the trees. If it is necessary to use these sprayers, they should be scrubbed out thoroughly with soap and water and rinsed repeatedly.

SPRAY FORMULAS FOR INSECTICIDES AND FUNGICIDES

A number of well-tested formulas have been developed for preparing insecticides and fungicides (tables 20 and 21). Use of these formulas will help nurserymen protect nursery beds as well as larger trees in windbreaks near the nursery.

TABLE 20.—*Formulas for insecticides and fungicides, after Potts and Waterman (1952)*

Formula No.	Ingredients	Water	Sticker or spreading agent
	INSECTICIDES		
		Gallons	
1	Lead arsenate 2 to 5 (av. 4) lb.	100	1 pt. of fish oil.
2	Derris or cube powder 4% rotenone) 2–8 lb.	100	½ gal. fish oil.
3	Nicotine sulfate (40% nicotine) 1 pint.	100	3 lb. solid soap or 6 lb. liquid soap.
4	Pyrethrum powder (0.8 to 1% pyrethrins) 1 lb.	100	Do.
5	Emulsifiable pyrethrum extract (1% pyrethrins) 1 pint.	100	None.
6	Derris or cube powder (4% rotenone) 1.5 lb.	100	3 lb. solid soap or 6 lb. liquid soap.
7	Oil emulsion (75% oil) 4 gal.	96	None.
8	Miscible oil (90% oil) 5 gal.	95	Do.
9	Miscible white oils 1 gal...	100	Do.
10	Lime sulfur (10 gal. liquid or 40 lb. dry).	90	Do.
11	Parathion 1 lb.....	100	Do.
11a	Tetraethyl pyrophosphate (40% emulsifiable) ½ pt.	100	Do.
12	Aramite 15 W. Neotran, or Dimite, 2 lb.	100	Do.
13	DDT (emulsifiable, 25% DDT) 1 qt.	100	Do.
13a	DDT (50% DDT wettable powder) 1 lb.	100	Do.
	FUNGICIDES		
14	Lime sulfur (2.5 gal. liquid or 6–8 lb. dry).	100	None.
15	Bordeaux-copper sulfate 8 lb., hydrated lime 10 lb.	100	Calcium caseinate 2 lb.
16	Bordeaux mixture powder 16 lb.	100	Do.
17	Wettable sulfurs.....	(1)	According to directions on container.
18	Sulfur dust [2].....	0	None.
19	Puratized agricultural spray 1 to 1.5 pts.	100	Do.
20	Ferbam 1.5–2 lb.....	100	Do.
21	Ferbam ½ lb., wettable sulfur 3 lb.	100	Do.
22	Elgetol 1 gal.....	100	Do.

[1] According to directions on container.

[2] For control of chewing insects, 2 pounds of lead arsenate or 1 pound of 50 percent DDT powder can be added per 10 pounds of sulfur.

TABLE 21.—*Concentrated-spray formulations for use in mist blowers, aircraft, and hand atomizers, after Potts (1952)*

Formula No.	Ingredients	Quantity to make		Gallons to apply		Percent of toxicant
		1 gal.	100 gal.	Per acre	Per 60-ft. tree	
1	DDT	⅔ lb	40 lb	2¼	½	5
	Kerosene	1 gal	99 gal			
2	DDT, technical	½ lb	50 lb	2	½	6
	Xylene	1¼ pt	15⅔ gal			
	Kerosene	6¾ pt	81⅜ gal			
3	DDT, technical	½ lb	50 lb	2	½	6
	Xylene	1¼ pt	15⅔ gal			
	Triton X–100	¾ oz	⅝ gal			
	Water	6½ pt	82 gal			
4	DDT, 50% wettable powder	1 lb	100 gal	2	½	6
	Water	1 gal	97 gal			
5	Benzene hexachloride, emulsifiable 20% gamma isomer.	4 oz	3⅛ gal	4	1	.67
	Water	7¾ pt	97 gal			
6	Chlordane, 50% emulsifiable	1 pt	12½ gal	2	½	6
	Kerosene or water	7 pt	87½ gal			
7	Chlordane, 50% wettable powder	1 lb	100 lb	2	½	6
	Water	1 gal	97 gal			
8	Nicotine sulfate	8 oz	6¼ gal	4	1	2.5
	Water	7½ pt	93¾ gal			
9	Rotenone, 5% emulsifiable extract	1 pt	12½ gal	5	1½	.6
	Water	7 pt	87½ gal			
10	Rotenone, 5% powder	1 lb	100 lb	5	1¼	.6
	Water	7½ pt	94 gal			
	Mineral oil (50 to 90 sec. Saybolt)	3 oz	2½ gal			
11	Pyrethrum extract, 1% emulsifiable	1 pt	12½ gal	4	1	.125
	Water or kerosene	7 pt	87½ gal			
12	Lead arsenate	2 lb	200 lb	6	1½	21
	Water	7⅕ pt	90 gal			
	Mineral oil (50 to 90 sec. Saybolt)	⅖ pt	5 gal			
13	Refined white mineral oil (45 to 75 sec. Saybolt)	1 gal	100 gal	6	1½	100
14	Refined white miscible mineral oil (50 to 100 sec. Saybolt).	1 qt	26 gal	15	3¾	25
	Water	3 qt	74 gal			
15	DN–111	8 oz	50 lb	6	1½	6
	Water	1 gal	98½ gal			
16	Aramite 15W	1 lb	100 lb	6	1½	2
	Water	7⅗ pt	95 gal			
	Soybean oil or linseed oil	⅕ pt	2½ gal			
17	Liquid lime sulfur	1 gal	100 gal	15	3¾	100

MOUSE BAITS

Zinc Phosphide Formula

The zinc phosphide formula (Garlough and Spencer 1944) is as follows:

Steamed rolled oats	98 pounds.
Zinc phosphide	1 pound.
Amber petroleum jelly	10 ounces.
Mineral oil	10 ounces.

The mineral oil and petroleum jelly are warmed together until they are fluid, but not hot. Zinc phosphide is added to the mixture and stirred vigorously. This material is then poured over the oats and mixed thoroughly. Zinc phosphide baits are generally effective for about 3 weeks after preparation.

Strychnine Alkaloid Formula

Because of its bitter taste, strychnine alkaloid sometimes is not as readily accepted by certain mice. The formula is as follows:

Steamed rolled oats	12 pounds.
Powdered strychnine alkaloid	1 ounce.
Baking soda	1 ounce.
Gloss starch	¾ ounce.
Water	1 pint.
Heavy corn sirup	¼ pint.
Glycerine or petrolatum	1 tablespoonful.

The starch is mixed with one-fourth teacup of cold water, stirred into three-fourths pint of boiling water, and cooled until it forms a thin paste. Strychnine is

mixed with the baking soda, added to the starch paste, and stirred until free of lumps. The corn sirup and glycerine or petrolatum are then added. The mixture is poured over the oats and allowed to dry before sacking.

SOURCES OF INFORMATION ON NURSERY PROBLEMS

Nurserymen who have problems with nursery insects or diseases can obtain advice on identification and control by writing to their State agricultural college or their State nursery inspector; the latter is invariably a trained pathologist or entomologist. The inspector may also send out releases on new quarantine regulations affecting the nursery industry. Another source of information on nursery disease and insect problems is the Division of Forest Protection Research, Forest Service, U.S. Department of Agriculture, Washington, D.C., 20250.

Advice on control of mammals and birds can be obtained from the Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C., 20240, or from the conservation departments of the respective States.

Nurserymen who plan interstate shipments of stock should become familiar with Federal and State regulations which may affect their shipments. This information can be obtained from the Plant Quarantine Division, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C., 20250.

Problems on nursery soils can be referred to the soils departments of State colleges and universities.

SOURCES OF INFORMATION ON NURSERY MACHINERY, EQUIPMENT, AND CHEMICALS

The nursery industry as much as possible uses equipment and products of standard manufacture. A list of manufacturers of nursery machinery, equipment, and chemicals can be obtained from the Forest Service, U.S. Department of Agriculture, Washington, D.C., 20250.

Blueprints of specialized equipment, either assembled from manufacturers' parts or to be built by the nurseryman, can be obtained from one of the several regional offices of the U.S. Forest Service.

The North Central Region of the U.S. Forest Service (consisting of North Dakota, Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, Indiana, and Ohio) has blueprints of certain items of special equipment (tree lifters, hand trenchers, root pruners, tree balers, etc.) or of buildings (central warehouses, cold storage sheds, cone storage sheds, and extractories, etc.). Nurserymen can obtain these blueprints at cost by writing to the Regional Forester, U.S. Forest Service, Milwaukee, Wis.

In the Rocky Mountain Region (consisting of South Dakota, Nebraska, Kansas, Colorado, and a major portion of Wyoming) similar blueprints can be obtained by writing to the Regional Forester, U.S. Forest Service, Denver, Colo.

Requests of nurserymen in Oklahoma and Texas should be addressed to the Regional Forester, U.S. Forest Service, Atlanta, Ga.

Nurserymen in Montana can obtain blueprints from the Regional Forester, U.S. Forest Service, Missoula, Mont.

REQUIREMENTS AND PROCEDURES FOR NURSERY STOCK INSPECTION IN THE PLAINS STATES

Each State has laws requiring inspection of trees before they can be sold and removed from the nursery premises. In brief, these laws provide for an annual inspection of the nursery by the State nursery inspector or his representative, define the fees to be charged, and provide for the issuance of a certificate of inspection. The law names certain species on which there is a quarantine regarding shipment into the State; defines the power of the nursery inspector to recommend and enforce destruction of certain pest-infested stock or to enforce its treatment with appropriate insecticides or fungicides; provides for tagging State shipments of nursery stock and wildings; and provides for penalties for violations of quarantine and other aspects of nursery regulations.

Individuals in any of the Plains States contemplating growing or selling nursery stock can obtain detailed information on current laws affecting the business by writing to one of the following agencies:

1. In Colorado: State Department of Agriculture, 3130 Zuni Street, Denver, Colo.
2. In Kansas (for portion of State north of Smoky Hill and Kansas Rivers): Nursery Inspector, Department of Entomology, Kansas State College, Manhattan, Kans.
3. In Kansas (for portion of State south of Smoky Hill and Kansas Rivers): Nursery Inspector, Department of Entomology, University of Kansas, Lawrence, Kans.
4. In Montana: State Nursery Inspector, East Broadway, Missoula, Mont.
5. In Nebraska: State Entomologist and Nursery Inspector, Bureau of Plant Industry, State Capitol Building, Lincoln, Nebr.
6. In North Dakota: State Nursery Inspector, North Dakota State University, Fargo, N. Dak.
7. In Oklahoma: Nursery Inspector, Entomology Division, State Department of Agriculture, Oklahoma City 5, Okla.
8. In South Dakota: State Nursery Inspector, State Department of Agriculture, Pierre, S. Dak.
9. In Texas: State Entomologist, 308 Capitol Building, Austin, Tex.
10. In Wyoming: State Entomologist, 308 Capitol Building, Cheyenne, Wyo.

Plant quarantine regulations that are in force on a national basis by the U.S. Department of Agriculture are available from the Plant Quarantine Division, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C., 20250.

U.S. DEPARTMENT OF AGRICULTURE FOREST TREE SEED POLICY (1939)

The U.S. Department of Agriculture has adopted a forest tree seed policy regarding seeds of trees and shrubs to be used in reforestation, shelterbelt, and erosion control planting. It provides guidance for its various conservation agencies engaged in such work. The policy is given below:

Recognizing that trees and shrubs, in common with other food and fiber plants, vary in branch habit, rate of growth, strength and stiffness of wood, resistance to cold, drought, insect attack, and disease, and in other attributes which influence their usefulness and local adaptation for forest, shelterbelt, and erosion-control use, and that such differences are largely of a genetic nature, it shall be the policy of the United States Department of Agriculture insofar as practicable to require for all forest, shelterbelt, and erosion-control plantings, stocks propagated from segregated strains or individual clones of proven superiority for the particular locality or objective concerned.

Furthermore, since the above attributes are associated in part with the climate and to some extent with other factors of environment of the locality of origin, it shall be the policy of the U.S. Department of Agriculture:

1. To use only seed of known locality of origin and nursery stock grown from such seed.

2. To require from the vendor adequate evidence verifying place and year of origin for all lots of seed or nursery stock purchased, such as bills of lading, receipts for payments to collectors, or other evidence indicating that the seed or stock offered is of the source represented. When purchases are made from farmers or other collectors known to operate only locally, a statement capable of verification will be required as needed for proof of origin.

3. To require an accurate record of the origin of all lots of seed and nursery stock used in forest, shelterbelt, and erosion-control planting, such records to include the following minimum standard requirements to be furnished with each shipment:

(1) Lot number.
(2) Year of seed crop.
(3) Species.
(4) Seed origin: State—County—Locality—Range of elevation.
(5) Proof of origin.

4. To use local seed from natural stands whenever available unless it has been demonstrated that seed from another specific source produces desirable plants for the locality and uses involved. Local seed means seed from an area subject to similar climatic influences and may usually be considered as that collected within 100 miles of the planting site and differing from it in elevation by less than 1,000 feet.

5. When local seed is not available, to use seed from a region having as nearly as possible the same length of growing season, the same mean temperature of the growing season, the same frequencies of summer droughts, with other similar environment so far as possible, and the same latitude.

6. To continue experimentation with indigenous and exotic species, races, and clones to determine their possible usefulness, and to delimit as early as practicable climatic zones within which seed or planting stock of species and their strains may be safely used for forest, shelterbelt, and erosion-control.

7. To urge that States, counties, cities, corporations, other organizations, and individuals producing and planting trees for forest, shelterbelt, and erosion-control purposes, the expense of which is borne wholly or in part by the Federal Government, adhere to the policy herein outlined.

WHERE TO PURCHASE SEED

A partial list of tree-seed dealers in the United States and a few foreign countries can be obtained by writing to the Forest Service, U.S. Department of Agriculture, Washington, D.C., 20250.

A list that includes tree-seed dealers in the Plains States and dealers who handle seed native to the Plains States can be obtained from the Rocky Mountain Forest and Range Experiment Station, Colorado State University, Fort Collins, Colo.; and the Lake States Forest Experiment Station, St. Paul Campus, University of Minnesota, St. Paul 1, Minn.

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PEACH PRODUCTION EAST OF THE ROCKY MOUNTAINS

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Agricultural Research Service
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PRECAUTIONS

Pesticides are poisonous to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Keep pesticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and pets cannot reach them.

Avoid repeated or prolonged contact of pesticides with the skin. Avoid inhalation of pesticide dusts or mists.

Avoid spilling pesticides on your skin, and keep them out of the eyes, nose, and mouth. If any is spilled on skin or clothing, wash it off the skin and change clothing immediately.

When handling pesticides, wear clean, dry clothing.

Wash your hands and face before eating or smoking and immediately after completing pesticide application.

To protect fish and wildlife, do not contaminate lakes, streams, or ponds with pesticide. Do not clean spraying equipment or dump excess spray material near such water.

To minimize losses of honey bees and other pollinating insects, make pesticide applications, when possible, during hours when the insects are not visiting the plants. Avoid drift of pesticide sprays to nearby crops or livestock. Avoid drift of pesticides into bee yards.

Empty containers are particularly hazardous. Burn empty bags and cardboard containers in the open or bury them. Crush and bury bottles or cans.

Credit for preparation of the basic information in this handbook on culture of peaches and compilation of the initial draft of the handbook is due A. Leon Havis, formerly horticulturist, Crops Research Division, Agricultural Research Service. Dr. Havis died in 1962.

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CONTENTS

	Page
History of the peach	1
Geographic distribution of peaches in the United States	2
Selecting orchard sites	4
Selecting varieties	6
Standard commercial varieties	7
Special-purpose varieties	10
Promising new varieties	12
Propagating and selecting rootstocks	13
Planting the orchard	15
Age and size of trees	15
Time to plant	15
Planting patterns and spacings	16
Preparing the site	17
Setting out the trees	18
Replanting the orchard	18
Training and pruning	18
The young tree	19
The bearing tree	21
Time of pruning	28
Pruning in relation to fruit thinning	29
Pruning in relation to fertilizing	29
Pruning tools and equipment	30
Soil management	30
The young orchard	31
The bearing orchard	33
Fertilizers	35
Nitrogen	35
Potassium, phosphorus, magnesium, and calcium	37
Zinc, boron, and manganese	39
Irrigation	39
Thinning the fruit	40
Thinning according to variety	40
Amount to thin	41
Methods of thinning	42
Low-temperature injury	42
Injury to buds	42
Injury to twigs, branches, and trunks	44
Injury to roots	44
Harvesting, transporting, and storing fruit	44
Diseases caused by fungi and bacteria	50
Brown rot	50
Scab	52
Bacterial spot	53
Leaf curl	55
Rust	56
Constriction	56
Crown gall	57
Powdery mildew	57
Fungus root rots	57
Dieback	57
Diseases caused by viruses	58
Peach yellows	58
Little peach	61
Red suture	61
X-disease	62
Phony disease	63
Peach rosette	64
Peach mosaic	64
Rosette mosaic, ring spot, necrotic leaf spot, line pattern, and asteroid spot	66
Peach insects	67
Plum curculio	67
Peach tree borer	67
Lesser peach tree borer	68
San Jose scale	68
Oriental fruit moth	68
Sucking bugs	68

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PEACH PRODUCTION EAST OF THE ROCKY MOUNTAINS

By H. W. Fogle,[1] H. L. Keil,[1] W. H. Redit,[2] L. C. Cochran,[1] and H. Baker[3]

HISTORY OF THE PEACH

The peach (*Prunus persica* (L) Batsch) originated in China and was taken from there into Persia, Greece, Italy, and other temperate areas of Europe.

Probably the earliest introduction of peaches into the Western Hemisphere was by the Spaniards, who brought them to Mexico. In 1565, Spanish settlers brought peaches to St. Augustine, Fla. The early English and French settlers also brought peach seeds with them to the Eastern United States. Later, Indians planted peach seeds over a wide area.

Until about 1910, most peach varieties originated as chance seedlings. The first peaches grown in this country were probably white fleshed. They were later crossed with yellow-fleshed peaches brought from Mexico. All commercial varieties now grown in the United States originated in this country. The most important new varieties originated from controlled crosses made at State or Federal experiment stations or by private fruit breeders.

For 200 years after their introduction into the United States, seedling peaches were grown mostly for brandy, for fresh fruit for the home, or for hog feed. Almost every farm and plantation in the Middle Atlantic States had a peach orchard. No spraying was done, but the trees evidently produced well. By about 1800, several good varieties had been selected from seedlings and propagated by budding. By 1850, more than 400 varieties were listed by nurseries in this country.

From 1800 to 1850, commercial peach production expanded rapidly. Peaches were transported by rail, by boat, and by wagon to supply the demand for fresh peaches in the cities. Peach production mostly was for family use, although commercial orchards were being developed near Richmond, Norfolk, and Baltimore. Peach seedlings, as well as budded varieties for home use, were carried west by settlers during the 19th century.

Commercial shipment of peaches to terminal markets developed gradually from 1870 to 1900. Selection of the Elberta and Belle varieties and development of the refrigerated rail car were important in market expansion. Commercial peach growing increased in Virginia, Maryland, Delaware, New Jersey, and southeastern New York.

Throughout the 19th century, disease and insect problems multiplied as commercial peach production in America expanded. Peach yellows and brown rot diseases and insect borers became increasingly destructive. The yellows virus, which became serious in the Philadelphia area about 1800, caused greater loss of peach trees in Northeastern

[1] Crops Research Division.
[2] Market Quality Research Division.
[3] Entomology Research Division; now retired.

United States than did any other trouble. The most serious losses occurred between 1850 and 1900 in New Jersey, in Delaware, and on the Eastern Shore of Maryland. Thousands of trees and many large plantings were completely destroyed. Serious losses also occurred as far west as Ohio and Michigan, but the virus caused no damage to the developing peach areas in the Southeast. In 1892, the San Jose scale insect appeared in Virginia and quickly spread to other fruit areas. Spring frosts were a major hazard to the growing commercial peach industry. The appearance of San Jose scale in 1892 in Virginia and its rapid spread to other fruit areas led to the adoption of spraying as an orchard practice. A realization of the value of spraying for other insects and diseases soon developed.

Most of the early commercial orchards were clean cultivated. Pruning methods were variable and sometimes severe. Before the use of nitrogenous fertilizers in orchards, clean cultivating and heavy pruning were practiced in some locations to stimulate vigorous annual growth. Peach varieties selected between 1850 and 1900 that are still grown commercially include Elberta, Belle, and Champion, and, to a lesser extent, Carman and Hiley.

From 1900 to 1920, the peach industry in the United States expanded, especially in Georgia, South Carolina, Arkansas, Texas, and California. Production reached its peak economically in the United States during this period. Then fruit prices suddenly fell, and thousands of acres of peach trees were abandoned.

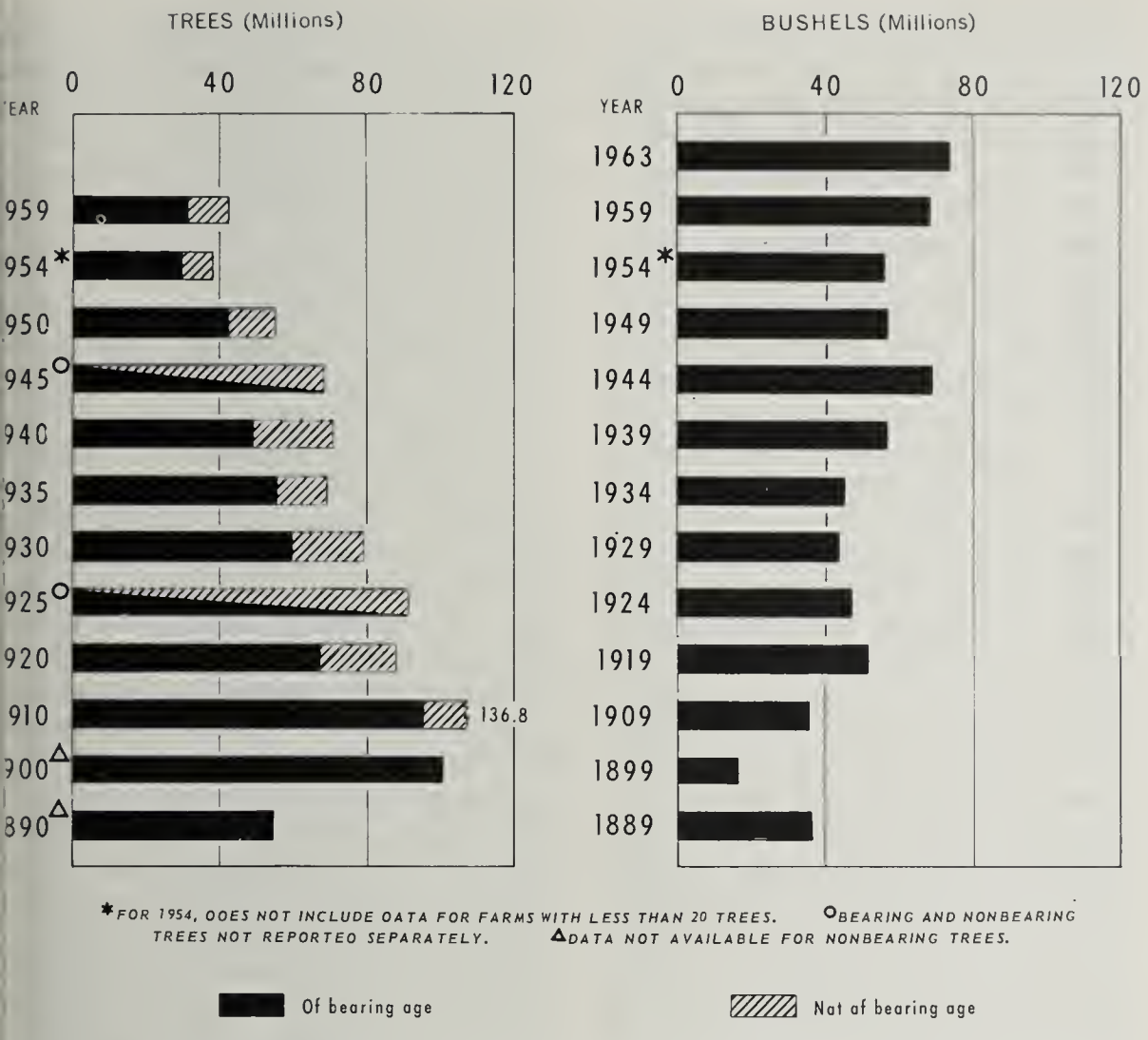
The economic recovery was slow and irregular, even for the most efficient growers and at the best cultural locations. World War II brought high peach prices, but it also brought shortages of labor, equipment, and supplies. In the postwar period, the high cost of labor, equipment, sprays, fertilizers, and land made profits uncertain in most areas. Although high production per acre of high-quality fruit over a long period of years has usually been profitable, such hazards as spring frost, winter injury, insects, diseases, and hail continued to plague fruit growers.

Since 1890, the number of peach trees in the United States has fluctuated but has generally declined (fig. 1). However, during the same period production has increased.

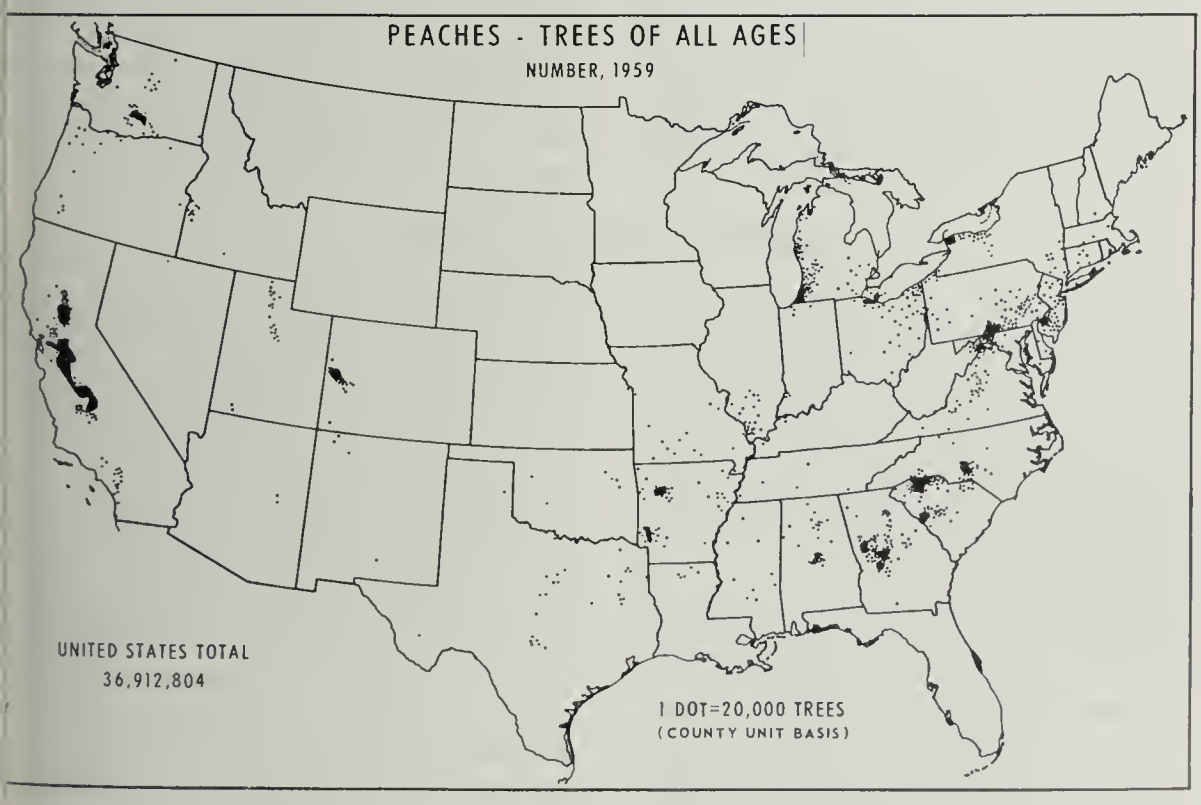
GEOGRAPHIC DISTRIBUTION OF PEACHES IN THE UNITED STATES

Commercial culture of peaches is more widespread in the United States than that of any other tree fruit, even though in many areas annual production is uncertain and variable. Peaches are produced commercially over a wide area that begins in New Jersey, extends into the South Atlantic States, and reaches into central Texas. Peach-producing sections within this area include parts of the Piedmont and the Coastal Plain. The Piedmont extends from south-central Georgia through the Carolinas and Virginia and into Maryland, and includes parts of the Coastal Plain in the Carolinas, Maryland's Eastern Shore, Delaware, and New Jersey. Many large plantings border the Great Lakes in western New York, northern Ohio, and southwestern Michigan.

In the Far West, climate and soil in the San Joaquin and Sacramento River Valleys of California are exceptionally favorable to commercial peach production. This fact has stimulated heavy planting. Peaches are also grown under irrigation in western Colorado, northern Utah, southern Idaho, and central Washington (fig. 2).



IGURE 1.—Number of peach trees in the United States and annual production, 1889–1963.



IGURE 2.—Location of principal peach tree plantings in the United States in 1959. Greatest concentrations of plantings are in California, South Carolina, Georgia, and Michigan.

Large-scale peach production in a given locality may mean that peaches grow especially well there, or it may mean only that they grow better there than do other crops.

Some areas in this country are not suitable for peach growing. Many States in the North and several States in the Great Plains and the Rocky Mountain region have such cold winters that only the hardiest peach varieties survive, and even those varieties often fail to bear fruit. In extreme south Georgia, in Florida, and in the southern parts of the States bordering the Gulf of Mexico, none of the leading peach varieties produces well enough to be grown commercially because the winters are too warm. Although peach trees do not thrive where winter weather is severe, their buds do require some winter chilling. If a peach tree does not have enough chilling during the winter, its shoot growth and blossoming are delayed the next spring and, after particularly mild winters, fail to develop at all. Most leading peach varieties require chilling below 45° F. for 600 to 1,400 hours.

Flowerbuds of most varieties require slightly less chilling than do leafbuds. Flowerbuds of peaches are formed only in axils of leaves, and they vary from none to three. Usually at least one leafbud occurs in the axil of each leaf, and the terminal bud on the twig is always a leafbud. Leafbuds and flowerbuds are formed during the summer, develop slowly during the winter, and develop rapidly in warm weather after the required chilling time.

For the 10-year period 1951–60, annual peach production in the United States averaged 65,650,000 bushels. From 1944 to 1948, commercial peach production reached its highest average for a 5-year period—75,442,000 bushels. The 1959–63 crops also averaged more than 75 million bushels. Production from 1956 to 1963 averaged 72 million bushels annually. The States having the highest production and their approximate average yields, for this 8-year period were: California—40 million bushels (including 28 million clingstones and 12 million freestones); South Carolina—5 million bushels; Georgia—4 million bushels; Michigan—3 million bushels; Pennsylvania—2,700,000 bushels; New Jersey—2,300,000 bushels; Washington—1,750,000 bushels; Arkansas, Virginia, Colorado, and North Carolina—about 1,500,000 bushels each. Improved peach varieties and improved methods of canning, freezing, and transporting are increasing the potential consumption of high-quality peaches in the United States.

SELECTING ORCHARD SITES

In selecting a peach orchard site, not only the elevation, topography, and slope of the land but also the depth, moisture-holding capacity, and other physical features of the soil should be carefully considered. Satisfactory sites are found on both hilly and level land.

In the peach-producing areas of the South Atlantic and South Central States, few sites have winter temperatures low enough to injure dormant flowerbuds. But on many sites, fruit crops may be lost because of frost at blossoming time. In the New England, Middle Atlantic, and East Central States, peach orchard sites should be selected that offer protection from occasional spring frosts and from severe winter cold.

Orchards on sites having poor air drainage are most likely to suffer from winter cold and spring frost. On clear, cold, still nights, heat is lost from the earth by radiation. Warm air rises and is replaced by a layer of cold air near the ground. At higher levels, the corresponding layer of air is warmer. A difference of only a few feet in elevation may

mean a difference of one to several degrees in temperature during the critical period of a frosty night. If air movement is slowed down by a ridge or by trees, cold air may accumulate behind them in pockets on the slopes. In most localities, therefore, the site for a peach orchard should be on land elevated above adjacent land and free of obstructions to air movement, so that cold air can settle to the lower levels. Gently sloping or level land may be satisfactory where the climate is mild or where a nearby body of water affords natural protection from cold.

An orchard on the leeward side of a large body of water is often protected from spring frost because the temperature of the water has a modifying effect that prevents sudden, severe drops in air temperature. Orchards planted near bodies of water are found on strips of land 10 to 15 miles wide along the eastern shore of Lake Michigan and the southern shore of Lake Ontario. Masses of cold air blowing over these lakes are warmed by the water. Also, air movement across the cold water in early spring tends to prevent sudden rises in air temperature that would cause peach blossoms to open too early and be injured later by low temperatures.

Although a peach orchard site usually should be at an elevation higher than that of the adjoining land, a hilltop location has a disadvantage if it exposes trees to cold, drying winds during winter. Peach trees planted on sites exposed to strong, prevailing winds not only may be damaged by cold but also may be permanently dislodged. This is especially true in young orchards where high winds accompany heavy rains that have softened the soil.

Before selecting his peach orchard site, an orchardist should determine the lowest winter and spring temperatures for that location. This he can do by placing, at different elevations on the site, thermometers that will automatically record minimum daily air temperature.

Peach trees grow well on a variety of soils, ranging from coarse sand or shale to fine-textured clay loams. Nevertheless, they will not grow so well on heavy soils as will apple and pear trees. Soils poorly drained or poorly aerated are not satisfactory for peach trees. During their growing season, peach trees are very likely to be injured if the orchard water table is temporarily raised by heavy rains or by accumulation of irrigation water. Where excess water does not pass through the soil quickly but accumulates and fills the pore spaces between soil particles, it shuts off the oxygen supply to the tree roots, which die. Tree injury caused by excess water is often indicated by yellowing of the foilage in early summer, especially where soil becomes saturated with water soon after peach trees start growing in the spring. Winter injury to peach trees in water-saturated soil, as well as trunk and root disease injury, is frequently severe and may result in early death of the trees. The best peach orchards are on well-drained sandy or gravelly loam soils.

Although the lighter soils (such as the coarse sands, gravels, and shales) usually have better aeration and drainage, they may not drain well if underlaid by impervious clay, hardpan, or rock. Too much water may accumulate near the root zone of the trees after heavy summer and fall rains. The low water-retention characteristic of lighter soils is not always an advantage in localities where summer droughts occur and irrigation is not practiced. For satisfactory growth and fruit production, peach trees require a water supply that is readily available.

An ideal soil for peaches is one

having about 8 feet of sandy loam underlaid by a clay loam capable of retaining and storing most of the rainfall.

Hillside sites, besides having good air drainage, often have satisfactory surface drainage of excess rainwater. On some hillsides the soil is only 3 or 4 feet deep. Trees will grow in shallow soil in the humid regions where the rainfall averages 4 or 5 inches a month during the growing season, or where the trees are irrigated. In regions where rainfall may be deficient for periods of from 4 to 6 weeks in the summer or where there is no irrigation, shallow coarse soils cannot store enough water to meet the needs of the trees.

Since selecting a peach site is so important, prospective growers should consult their local experiment station and extension specialists. In general, the following factors should be considered:

1. Spring frost protection on higher locations and from nearby lakes.
2. Protection from wind and low temperatures by planting on least exposed locations.
3. Soil-water drainage in deep loam soils.
4. Soil-moisture capacity desired for best fruit development.

SELECTING VARIETIES

Since 1940, many new peach varieties have been developed. In this handbook, only the leading commercial and certain outstanding, new special-purpose varieties are described (table 1). For specific varietal recommendations, consult your local experiment stations and cooperative extension personnel. Local environment and marketing outlets determine the varieties grown. For example, if peaches are grown for a nearby market, high-quality varieties that ripen in sequence during the season rather than varieties especially suited for shipping to distant markets should be grown. In many sections, the hardiness of flowerbuds is important in selecting a variety for a specific climate. Dependable annual production is necessary for successful peach growing.

Based on flesh texture, peach varieties are classified as either melting (such as Elberta), or nonmelting (such as Ambergem). Melting varieties are grown for dessert and for processing. Nonmelting varieties are grown almost entirely for processing. Most early-ripening varieties with melting flesh such as Dixired are freestones genetically but the flesh adheres tightly until the fruit is overripe. Most late-ripening varieties, however, are entirely freestones. Varieties with nonmelting flesh are all clingstones.

Peaches ripen over a period of about 3 months. For convenience in describing varieties, the ripening period has been arbitrarily classified into four general seasons of ripening:

1. Very early—more than 5 weeks earlier than Elberta and generally referred to as the Dixired season.
2. Early—from 3 to 5 weeks earlier than Elberta and referred to as the Redhaven season.
3. Midseason—less than 3 weeks earlier than Elberta. This season is usually divided into the Halehaven or July Elberta season (or varieties about 2 weeks before Elberta), and the Elberta season.
4. Late—all varieties ripening after Elberta. This is usually called the Rio Oso Gem season.

Comparative ratings of economically important varietal characteristics are given in table 1. The varietal descriptions that follow give the ripening period and certain outstanding strong or weak characteristics of (1) standard commercial

varieties, (2) special-purpose varieties, and (3) promising new varieties.

Elberta is still the leading peach variety, although it has become less popular in recent years. Varieties with high quality and attractiveness, such as M. A. Blake and Redskin, are replacing Elberta for the Elberta season of ripening. Likewise, Golden Jubilee and Halehaven, which were very popular a few years ago, are being replaced in their ripening season by such varieties as Redhaven, Sunhigh, Richhaven, and Redglobe. Firmness and attractiveness are the chief merits of these newer varieties.

Standard Commercial Varieties

The following peach varieties, listed in approximate order of ripening, are suitable for general commercial production east of the Rocky Mountains:

Dixired.—Very early, ripening 5 to 6 weeks before Elberta. Fruits medium sized. Blush bright red. Flesh yellow, medium firm; melting, with strong tendency to cling. Promising for very early shipping or for local marketing where earliness is of prime importance and where freeness of the pit is not required. Considerable acreage planted in the Southeast.

Redhaven.—Early, ripening 4 to 5 weeks before Elberta. Fruits require early and heavy thinning to develop best size. Skin bright red, attractive; flesh yellow. Usually freestone when ripe. Flowerbuds moderately hardy. Variety becoming more and more popular because of fruit's firmness, attractiveness, and earliness. Excellent for canning and freezing.

Golden Jubilee.—Early, ripening 3 to 4 weeks before Elberta. Fruits medium sized, attractive red blush and yellow undercolor. Shape compressed, especially in southern areas. Flesh yellow and medium soft; freestone. Flowerbuds fairly hardy. Fruits should be thinned early and well. Valuable where hardiness is important and market is nearby. Not firm enough for distance shipping.

Triogem.—Early, ripening about 3 weeks before Elberta. Fruits medium sized, with attractive skin color. Flesh yellow, fine textured, and firm; usually freestone. Flowerbuds tender to low temperatures. Fruit may be small unless thinned well and early.

Sunhigh.—Early midseason. Fruits large. Skin attractive, light, solid red. Flesh attractive, fine texture, yellow, firm; usually freestone. Buds fairly hardy to low winter temperature, but apparently sensitive to low temperature in early spring. Susceptible to bacterial spot. Relatively short chilling period required.

July Elberta.—Midseason, ripening about 2 weeks before Elberta. Fruits large, round. Flesh yellow and fairly firm; freestone. Trees productive. Chilling period short. One of the best commercial varieties for its season in several peach areas.

Halehaven.—Midseason, ripening 2 weeks before Elberta. Fruits large, round. Skin color sometimes dull. Flesh yellow and fairly firm for season; freestone. Flowerbuds fairly hardy. Trees vigorous and productive. Fruit set often heavy, making detailed thinning necessary.

Belle (Belle of Georgia).—Midseason. Flesh white, or high quality; usually freestone. Skin sometimes lacks color. Flowerbuds hardy. Usually preferred as a white variety ripening just before Elberta, but not planted extensively.

Sullivan's Early Elberta.—Midseason, ripening 1 week before Elberta. Similar to Elberta in all respects except earlier ripening. One of the most extensively planted varieties several years ago, especially in the Southeast.

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TABLE 1.—*Characteristics of some peach varieties for use east of the Rocky Mountains, listed in approximate order of ripening*

[Numerical ratings of quality characteristics range from 1 to 10; the higher values indicate more desirable characteristics]

Ripening season and variety	Approximate ripening date, in days before or after Elberta [1]	Color of flesh	Fruit size	Stone freeness	Attractiveness	Flesh firmness	Dessert quality	Canning quality	Bacterial spot resistance	Chilling requirements (hours below 45° F.)	Principal value [2]
Very early:											
Redwin	−63	White	5	4	6	4	6	4		800	HLC
Marcus	−63	Yellow	5	4	6	4	6	4	5	800	HLC
Springtime	−61	White	3	3	7	3	6	3	6	650	HLC
Earligold	−60	Yellow	4	3	6	3	6	3		600	HLC
Mayflower	−58	White	3	3	6	3	5	3	7	1, 200	HLC
Earlired	−50	Yellow	6	5	8	6	7	4	7	850	HLC
Collins	−49	Yellow	5	5	8	6	7	4			HLC
Sunrise	−48	Yellow	5	5	7	5	6	4	8	900	HL
Cardinal	−46	Yellow	6	4	8	6	7	4	7	950	LC
June Gold	−45	Yellow	6	5	7	6	5	3	5	700	HL
Early Redhaven	−44	Yellow	6	5	8	7	7				LC
Dixired	−42	Yellow	6	4	7	6	7	4	8	1, 000	LC
Maygold	−42	Yellow	6	4	7	6	7	4	6	650	LC
Redcap	−42	Yellow	6	4	8	6	8	4	7	750	LC
Erly-Red-Fre	−40	White	7	6	7	6	8	4	8	900	HL
Merrill Gemfree	−38	Yellow	7	6	6	7	7	5	6		LC
Sunhaven	−38	Yellow	7	6	7	7	8	5	8	900	HLC
Early:											
Starking Delicious	−35	Yellow	7	6	7	7	8	6	6	800	HL
Coronet	−33	Yellow	7	7	9	8	9	7	6	750	HLC
Jerseyland	−33	Yellow	8	8	6	8	8	7	4	850	LC
Dixigem	−32	Yellow	7	7	7	7	9	7	7	850	LC
Redhaven	−30	Yellow	7	7	8	8	8	7	8	950	HLC
Regina	−30	Yellow	8	7	7	8	8	7	6	850	LC
Raritan Rose	−27	White	8	8	8	6	9	7	9	950	HL
Golden Jubilee	−25	Yellow	8	8	7	6	8	8	8	850	HL
Goldgem	−25	Yellow	8	6	7	8	7	7	7		L

Ranger	−25	Yellow	8	8	7	8	8	8	9	950	LC
Suwanee	−25	Yellow	8	8	8	8	8		5	650	LC
Washington	−24	Yellow	8	8	8	8	8	8			LC
Keystone	−22	Yellow	9	8	8	9	8	8	7	700	C
Triogem	−22	Yellow	8	8	7	8	8	7	6	850	HLC
Midseason:											
Fairhaven	−19	Yellow	8	8	7	7	8	8	7	850	L
Sunhigh	−17	Yellow	9	8	8	8	9	9	4	750	C
Richhaven	−16	Yellow	9	9	9	9	9	9	4	1, 000	LC
July Elberta	−15	Yellow	8	9	7	8	9	9	5	750	HL
Ambergem	−14	Yellow	7	1	7	10	7	9	6	800	C
Southland	−14	Yellow	9	9	9	9	9	9	6	750	HLC
Halehaven	−14	Yellow	9	9	6	7	9	8	7	850	LC
Redglobe	−14	Yellow	9	9	10	10	9	9	7	850	HLC
Loring	−11	Yellow	9	9	9	9	9	9	8	800	LC
Veteran	−11	Yellow	8	8	8	7	9	8	8	1, 100	HL
Belle	−8	White	8	9	6	7	9	8	9	850	HL
Suncrest	−8	Yellow	9	9	9	10	9	9	4	850	LC
Sullivan's Early Elberta.	−7	Yellow	9	9	7	8	8	8	6	900	C
Allred Elberta	−4	Yellow	9	9	7	9	9			900	LC
M. A. Blake	−3	Yellow	9	9	9	9	8	7	7	750	LC
Early Elberta	−3	Yellow	9	9	8	9	9	9	8	850	LC
Redskin	0	Yellow	9	9	9	9	9	8	9	650	HLC
H. H. Brilliant	0	Yellow	9	9	9	9	9	8	5	750	LC
Elberta	0	Yellow	9	9	8	9	8	8	7	900	C
Dixiland	0	Yellow	9	9	9	9	9		8	750	C
J. H. Hale	+1	Yellow	10	9	9	10	9	7	6	900	C
Jefferson	+2	Yellow	9	9	9	10	9				C
Late:											
Shippers Late Red	+3	Yellow	10	9	9	10	9	7	5	850	C
Afterglow	+5	Yellow	9	9	7	9	8	7	7	750	C
Rio Oso Gem	+6	Yellow	10	9	8	10	9	8	7	900	C
Kimbo	+8	Yellow	9	9	8	9	9				LC
Laterose	+8	White	9	9	8	8	9	7	7	850	LC
Constitution	+10	Yellow	9	9	7	8	8	7	7	750	C
Autumn	+12	Yellow	9	9	7	8	7	7	8	850	C
Salwey	+18	Yellow	9	9	7	8	7	7	7	1, 050	C
Krummel	+27	Yellow	9	9	7	9	7	7	7	900	C

[1] At Beltsville, Md. [2] H=home; L=local market; C=commercial market.

Elberta.—Fruits large, with red blush. Flesh yellow, firm, of fair to good quality; freestone. Flowerbuds sensitive to low temperature. Trees productive. By far the leading peach variety in the United States. Its popularity with growers is due to the large size, firmness, attractiveness, and shipping quality of its fruit; the vigor of the trees; and its suitability to many soil and climatic conditions. Although Elberta is still considered the principal commercial midseason variety, midseason varieties superior to it in quality, hardiness, and skin color are being planted in many orchards.

Rio Oso Gem.—Late, ripening nearly a week after Elberta. Fruits large, of good quality. Medium to bright blush. Flesh yellow, firm; freestone. Flowerbuds sensitive to low temperature. Trees rather weak, moderately productive. Susceptible to bacterial spot. Popular with many growers because of size, firmness, attractiveness of fruit, and time of ripening.

Special-Purpose Varieties

The following peach varieties are suitable for certain localities for special purposes, or for extending the ripening season. These varieties are listed in the approximate order of ripening:

Mayflower.—Very early, ripening about 8 weeks before Elberta. Fruits small. Skin mostly red. Flesh white, soft, juicy; clingstone. Yields usually low. Early ripening the only merit.

Hiland.—Very early, ripening about 6 weeks before Elberta, about 2 weeks before Redhaven, and a few days before Redcap. Fruits medium to large. Flesh yellow, medium firm, melting; clingstone. For very early shipping in present southern commercial peach areas. Chilling requirement low.

Cardinal.—Very early, ripening about same time as Hiland. Fruits medium sized. Skin bright and attractive. Flesh yellow, firm, melting; clingstone. For very early shipment in areas where there is enough winter chilling for varieties such as Elberta.

Redcap.—Very early, ripening a few days later than Hiland and same time as Dixired. Fruits medium sized. Skin bright red. Flesh yellow, firm, melting; clingstone. Used for early shipping variety in southern areas. Chilling requirement fairly low.

Maygold.—Very early, ripening same time as Redcap and Dixired. Fruits medium sized, and well colored. Flesh yellow, medium firm, melting; clingstone. Used for early shipping in southernmost commercial peach-growing areas. Will grow slightly farther south than either Hiland or Redcap.

Erly-Red-Fre.—Very early, ripening 5 to 6 weeks before Elberta. Fruits large for early season. Skin partly red. Flesh white; often freestone when fully ripe. Trees productive and winter hardy. Flowerbuds hardy to low winter temperatures.

Prairie Dawn.—Very early, ripening 5 weeks before Elberta, or about 1 week before Redhaven. Fruits medium to large. Skin partly red. Flesh yellow, medium firm; usually freestone when ripe. Resistant to bacterial leaf spot. Flowerbuds hardy to low winter temperatures.

Coronet.—Early, ripening 4 to 5 weeks before Elberta. Fruits medium sized. Skin mostly red and very bright. Flesh yellow, firm; usually freestone. Low chilling requirement similar to that of Redcap. Early flower development sometimes damaged by spring frost. An attractive shipping peach, often used to follow Redcap harvest in the South.

Jerseyland.—Early, ripening 4 to 5 weeks before Elberta. Fruits

ıedium to large. Skin often solid ed. Flesh yellow, firm; usually reestone. Dependable production ver wide area. Susceptible to bac-erial spot disease.

Dixigem.—Early, ripening 4 to 5 eeks before Elberta and about week before Golden Jubilee. ruits medium sized. Bright yel-ow, with light-to-medium red over bout half the skin surface. Flesh ellow, firm, fine textured; usually reestone when ripe.

Raritan Rose.—Early, ripening 4 eeks before Elberta. Skin a right, attractive red. Flesh white, ne textured; freestone. Hardy nd productive. Has special merit or local sale where an early white ariety is desired.

Ranger.—Early, ripening same me as Golden Jubilee, or 3 to 4 eeks before Elberta. Fruits me-ium to large. Flesh yellow, firm; reestone. Dependable producer ver wide area. Blooms late and equires considerable chilling. Re-stant to bacterial spot disease.

Redglobe.—Early midseason, rip-ıing same time as July Elberta. ruits medium to large and attrac-ve. Flesh yellow, especially firm ıd fine textured; freestone. De-endable producer. Good shipping each.

Southland.—Early midseason, pening 2 to 3 weeks before El-erta, or with July Elberta. Fruits edium to large, round, firm, and tractive. Skin has medium blush. hilling requirement low. Has en planted for a shipping variety Southeastern United States.

Ambergem.—Early midseason. ruits medium sized, round. Flesh ellow, nonmelting, firm, fine tex-red; clingstone. Flowerbuds ırdy to low winter temperature—ightly more hardy than those of alehaven. Trees productive. sually planted for canning pur-oses. Preferable to western cling-one varieties for planting east of ocky Mountains.

Champion.—Midseason. Flesh white, fine textured, and of excellent dessert quality; usually freestone. Fruits lack firmness. Flowerbuds very hardy to low temperature. Susceptible to brown rot.

Redskin.—Midseason, ripening about same time as Elberta. Fruits large, round. Skin attractive and almost solid bright red. Flesh yellow, free, firm. Popular variety planted to replace Elberta in many areas because of its attractiveness and quality. Good for freezing and canning.

J. H. Hale.—Midseason, ripening same time as Elberta. Fruits large. Skin an attractive red. Flesh yellow, firm, fine textured, and of high dessert quality; freestone. Flowerbuds sensitive to low temperature. Cross-pollination necessary to fruit setting. Trees lacking in vigor, often not productive, and very susceptible to bacterial spot. Often unprofitable to grow in Eastern States, although fruit may bring a premium because of high quality.

Afterglow.—Late, ripening nearly 1 week after Elberta. Fruits large. Skin medium to light blush. Flesh yellow and firm. Flowerbuds fairly sensitive to low temperature. Trees moderately vigorous and productive. Although usually not so highly colored as Rio Oso Gem, Afterglow is sometimes preferred to it because of greater tree vigor and slightly greater flowerbud hardiness.

Laterose.—Late, ripening about 10 days after Elberta. Fruits medium to large. Skin attractive red blush. Flesh white, medium firm, and fine textured; freestone. Trees vigorous and productive. A good white variety to follow the Elberta season.

Lizzie.—Late, ripening about 2 weeks after Elberta. Fruits medium sized and lacking in skin color. Flesh medium firm, yellow, of fair-to-good quality. Flowerbuds sensitive to low temperature. Greatest

disadvantage, lack of skin color. Limited plantings.

Autumn.—Very late, ripening 3 to 4 weeks after Elberta. Fruits medium to large. Skin color often slightly dull. Flesh yellow, firm; freestone. Often lacks attractiveness and good flavor but is fairly satisfactory for a late peach.

Promising New Varieties

Many new peach varieties are promising but have not been tested thoroughly enough to be described accurately. Descriptions of some of the most promising new varieties follow in the approximate order of ripening.

Redwin.—Very early. Evidently a sport of Erly-Red-Fre, ripening at least 2 to 3 weeks earlier. Flesh white; semifreestone when fully ripe.

Marcus.—Very early, ripening a few days before Mayflower. Attractive yellow and red skin. Yellow flesh. Fruit medium sized.

Springtime.—Very early, ripening 2 to 3 days before Mayflower. Fruits small to medium sized. Skin usually almost solid red. Flesh white and juicy.

Dawne.—Very early. Attractive, yellow flesh.

Earlired.—Very early, ripening a few days before Cardinal and about 8 days before Sunhaven. Attractive, firm, with good flavor. Fruits medium sized and semifreestone.

Collins.—Very early, ripening just before Cardinal. Attractive skin color and relatively firm flesh. Fruits medium sized and semifreestone. Susceptible to bacterial spot disease.

Early Redhaven.—Very early, ripening about with Dixired. Attractive undercolor. Fruits firm and semifreestone.

Sunhaven.—Very early, ripening with Dixired or about 10 days before Redhaven. Fruits medium sized, round, but rough in more southern areas. Skin attractive, bright red. Flesh yellow, firm; semifreestone when ripe.

Goldenred.—Early, ripening several days after start of Redhaven season. Attractive yellow ground color. Fruits medium to large, round, and of good quality. Flesh yellow, medium firm; freestone.

Washington.—Early, ripening with Golden Jubilee. Fruits large, round, attractive. Flesh yellow, firm, and of good quality; freestone. Early tests indicate frost hardiness.

Keystone.—Early, ripening with Golden Jubilee. Fruits medium to large sized, round. Skin attractive, red and yellow. Flesh yellow, firm; freestone. Now being tested commercially to replace early white varieties with a yellow peach.

Goldgem.—Early, ripening in Golden Jubilee season. Flesh yellow, medium firm; freestone.

Suwanee.—Early, ripening between Golden Jubilee and Keystone seasons. Flesh yellow, firm, freestone. Low chilling requirement. Light pubescence.

Richhaven.—Midseason, ripening with Sunhigh and July Elberta, or often 2 days before Halehaven. Fruits medium sized to large and round. Skin color similar to Halehaven except brighter red and yellow. Flesh yellow, firm; freestone.

Summerqueen.—Midseason, ripening about same time as Sunhigh and July Elberta. Fruits medium sized to large. Flesh yellow, firm; freestone. Requires cross-pollination.

Loring. — Midseason, ripening during latter part of Halehaven season and extending that season. Fruits medium sized to large and round. Skin attractive red with yellow undercolor. Flesh yellow, firm; freestone. Resistant to bacterial spot disease. Most promising variety to extend the July Elberta-Halehaven season.

Suncrest.—Midseason, ripening with Sullivan Elberta. Fruits

large, round. Skin bright red if trees are very vigorous; otherwise red blush dull sometimes in Southeastern United States. Flesh yellow, firm; freestone. Very susceptible to bacterial spot.

M. A. Blake.—Midseason, usually ripens a few days before Elberta but after Sullivan Elberta. Fruits medium to large, round. Skin attractive, almost entirely red. Flesh yellow, firm, and of good quality; freestone.

Dixiland.—Midseason, ripening with or just before Elberta. Fruits large, ovate, freestone. Light pubescence. Low chilling requirement. Resistant to bacterial spot.

Jefferson.—Midseason, ripening same time as or just after Elberta. Fruits large, round. Skin attractive, bright yellow and red. Flesh yellow, very firm, and of good quality; freestone. Reported to withstand spring frosts well.

PROPAGATING AND SELECTING ROOTSTOCKS

Nurserymen offer a choice of sizes and grades of the popular and promising new varieties, guaranteed to grow and to be true to variety. Most peach growers, therefore, purchase their trees directly from reliable nurseries rather than propagate their own trees. Nevertheless, some peach growers may want to propagate their own trees for some special purpose such as reproducing a variety prized for jam or canning but not obtainable commercially.

A peach generally cannot be reproduced true to variety from seeds. Plants grown from seeds of a given peach tree may differ considerably in tree and fruit characteristics from the parent tree, even though there has been no cross-pollination. Seedlings of some varieties are more uniform than those of others. In reliable nurseries, the main purpose of germinating peach seeds is to grow young trees, called understocks, on which to bud or graft desired varieties.

Peaches may be propagated on most fruit trees in the *Prunus* genus, such as peach, plum, apricot, or almond. Compatibility and top growth vary among varieties of these species, however. In general, buds of desired varieties are compatible when budded to seedlings of the common peach varieties. Elberta and Halehaven peaches budded to seedlings grown from seeds of about 50 peach varieties showed little difference in tree size and yield.

For general rootstock purposes, peach seeds should be available in large quantity, should be economical, and should germinate well in the nursery. Previously, most seeds used for peach understocks came from seedling peach trees in the Carolinas, Kentucky, Tennessee, and elsewhere in the South. The supply of reliable seeds from these sources has dwindled, and understocks are now largely from seeds of Lovell, a variety used in California for drying. Lovell seeds make satisfactory understocks except where nematodes are numerous. The future supply of Lovell seeds is questionable because of reduced planting of this variety. Seeds of Elberta are available in large quantities, from canneries, but germination varies from year to year. Satisfactory germination of seeds of Elberta and other midseason and late varieties is usually obtained when the seeds are kept moist and given a longer chilling period than Lovell seeds. Trees on these rootstocks usually are very satisfactory. Seeds from red-leaved varieties are used by a few nurseries because this practice permits easy spotting of red-leaved trees developing from the rootstock seedling rather than the scion variety. Rogueing out the

red-leaved trees eliminates this source of error in producing true-to-variety trees.

Nematode injury to peach roots in some areas has resulted in importing, selecting, and breeding for nematode-resistant rootstock varieties (fig. 3). The Shalil variety from India and Yunnan from China gave resistance to the *acrita* nematode. The S–37 rootstock in addition gave slight resistance to the *javanica* species. Okinawa gave high resistance to both nematodes but lacked vigor. Nemaguard, introduced by the Department in 1961, combined vigorous seedling growth with dual resistance and high germination.

Understocks are being bred and tested for improved nematode resistance, higher seed yields, higher percentage of germination, vigorous top growth, and greater hardiness.

Peaches have been budded to many varieties and types of plum, apricot, and almond trees to test such characters as nematode resistance, winter hardiness, dwarfing, scion-stock compatibility, and tolerance to wet and dry soils. Results with some of the St. Julian or Damson plum varieties were encouraging but were not consistent. In other plum varieties, the bud onions usually were not compatible, or the trees were weak, dwarfed, and short lived for some other reason. Peaches budded on the western sand cherry (*Prunus besseyi*) are often sold as dwarf peach trees. They usually grow about 6 feet high and bear early, normal-sized fruit; but they are short lived. Heavy annual pruning of peaches grafted onto peach rootstocks, together with little nitogen fertilization, will produce a more satisfactory semidwarf peach tree.

Peach seeds should receive an afterripening treatment for about 3 months to insure high germination and normal seedling growth. The length of dormancy depends on the variety. The seeds should be stored over winter in damp peat or sand or in a mixture of the two, at a tem-

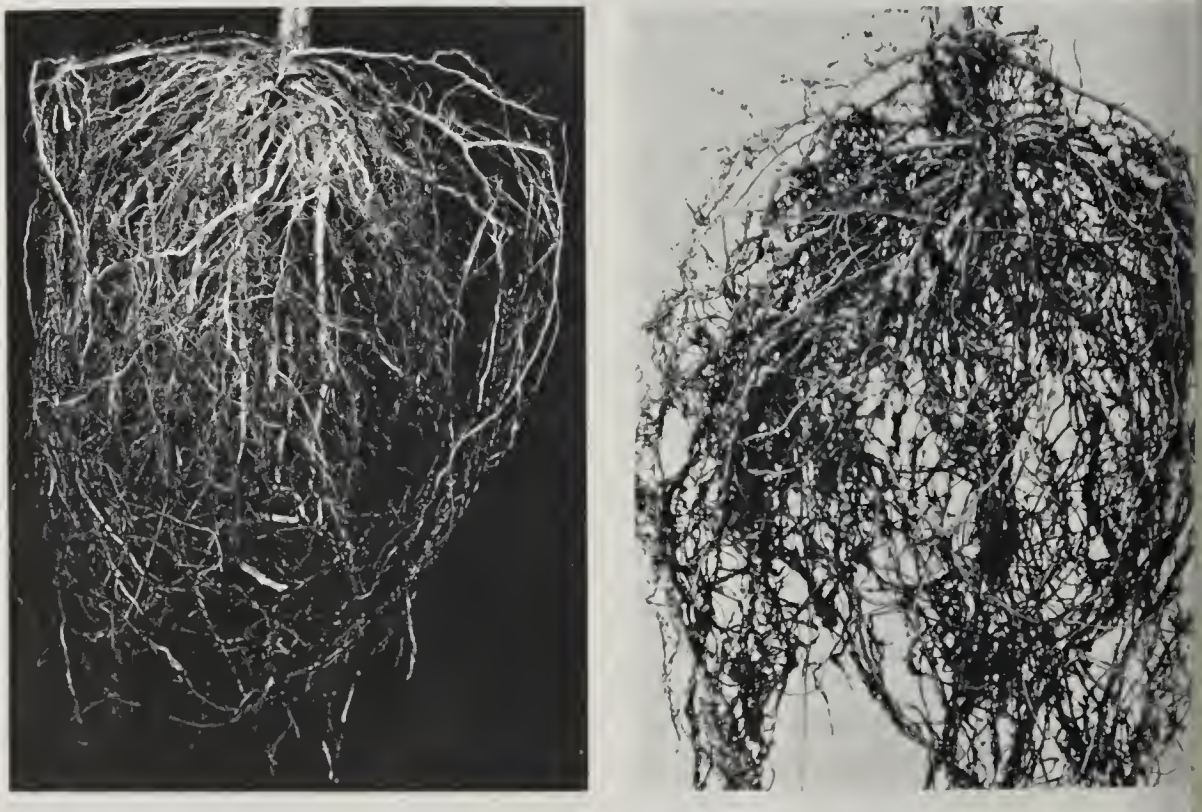


FIGURE 3.—Differences in root-knot nematode resistance of peach stocks. Left, nematode resistant stock; right, susceptible stock.

erature of 35° to 40° F. This eatment is called afterripening or ratification. Sometimes the seeds e afterripened outdoors in the fall moist sand. Some nurseries afripen the seeds in underground ts. It is not necessary that the eds freeze, but it is necessary that ey be kept cool and moist. Early the spring, after sufficient afterpening, the seeds are planted in e nursery or garden.

Planting peach seeds in the field the fall about 2 inches deep and rows about 4 feet apart is a more mmon practice than is stratification. Seeds so planted germinate e following spring. Too much oisture, which occurs when the soil poorly drained, injures the seeds d prevents high percentage of rmination. Special precautions ust sometimes be taken to protect e seeds from rodents.

Budding desired peach varieties onto young seedlings is done during the first year of seedling growth. The time for peach budding in the South is usually June; in the North, it is usually late July or August.

The shield, or T-budding, method is used. A T-shaped cut is made near the base of the seedling. A shield-shaped section of the bark of a tree of the desired variety containing one bud is inserted into the cut. The bud is then bound firmly into position with rubberbands, strips of raffia, or string. In about 2 weeks, or as soon as the bud has set, the strips or rubberbands are cut to prevent girdling. When the inserted bud starts growing, the seedling is cut off just above it. This is done soon after June budding and again early the next spring after late-summer budding. All growth except that from the desired bud is removed.

PLANTING THE ORCHARD

Age and Size of Trees

One-year-old nursery-grown each trees are usually the most tisfactory to plant. A 1-year-old ee is a tree that has had one comete season's growth in the nursery ter being budded. A tree that is dded early the first summer, as any are in the South, is dug at the d of the same season and is comonly referred to as a June-budded ee. June-budded trees are naller than most 1-year-old trees t are satisfactory for planting, pecially in regions that have long owing seasons. They may be raight, unbranched whips, or they ay have a few branches. Oneear-old nursery-grown trees are sually well branched.

Nurserymen who propagate large mbers of peach trees grade them cording to height in feet, or dineter in fractions of an inch. ell-grown June-budded trees are sually 2 to 3 feet tall and sometimes taller. For general-purpose planting, the medium-sized (4- to 5-foot), 1-year-old tree or the largest June-budded tree is satisfactory.

Time To Plant

Well-hardened, dormant peach trees may be transplanted from the nursery to the orchard in late fall, winter, or early spring. Generally, in the Southeast and the Southwest, the best time for transplanting the trees is during late fall or early winter. In the Middle Atlantic and Middle South Central States, the best time is late fall; and in the New England and North Central States, late winter or early spring.

Where below-zero temperatures occur, accompanied by high winds, and where soil without a snow cover freezes to a considerable depth, fall-planted trees may dry out considerably and be injured by cold. Trees planted in late winter or early spring should be set out as soon as

757-340 O—65——3

the soil is dry enough to be worked, so that new roots can become established while soil temperatures and moisture are favorable. Trees planted late in the spring, especially large trees, may become desiccated and have a high mortality. Leafbuds of the transplanted trees develop when temperatures become warm. It is important, therefore, that spring-planted trees be set out 3 or 4 weeks before the leafbuds start growth.

If trees are transplanted late in the spring, small- and medium-sized trees may have a lower rate of mortality than large trees at the end of the first season in the orchard. If large trees (5 to 7 feet) are planted in the fall or late winter (at least a month before growth starts), their mortality rate will be no higher than that of smaller trees planted at the same time. They will grow more during their first year in the orchard than will the smaller trees.

If trees are received from the nursery at an unsuitable time for planting because of soil or weather conditions, they should be placed in cool storage or "heeled in" outdoors to prevent drying out. "Heeling in" means laying the trees on the side of a trench in a sloping position and covering their roots with soil. If planting must be delayed, the soil should be packed tightly around the roots. If the trees are to be planted shortly, they may be protected sufficiently by wrapping some material such as burlap, excelsior, or old straw around their roots, thoroughly moistening this cover with water, and shielding the trees from wind and sun. Roots must be kept moist and cool but not allowed to freeze.

Planting Patterns and Spacings

Peach trees are usually set out in some rectangular pattern to permit tillage and other cultural work in any direction. Where the land is level or slopes no more than 5 feet in 100, a square pattern is commonly used; that is, the distance between trees in the row is the same as the distance between rows.

Contour planting and terracing to conserve soil and water in peach orchards is good practice where the soil erodes easily. On steep slopes or irregular land, trees should be contour planted. In contour planting, the trees are set about the same distance apart within the row; but each row follows a true contour line or else a line sloping so little that the soil drains but does not erode. The distance between rows in a contour-planted orchard varies with the degree of slope of the land. In such an orchard, cultivation and other operations are carried on only along the rows—never up and down the slope. By cultivating in one direction and working the soil toward the trees, a contour ridge is built up along each tree row.

The principal advantage of the contour method of planting is that soil erosion, which is often serious in cultivated orchards planted on the square system on sloping sites, is reduced to a minimum. Where the slope is steep, or where there is a broad watershed above the orchard from which a large amount of water may flow down into the orchard during heavy rains, it may be desirable to build terraces. Terraces check the flow of water down the slope, cause much of it to percolate into the soil, and divert the remainder into drainage ditches or flumes. A system of terraces should be planned before, rather than after, the orchard is planted.

For commercial peach production, the trees should be set no closer than 20 by 20 feet if the orchard is planted on the square. Even trees planted this far apart are frequently crowded by the time they are 8 years old (fig. 4). On fertile soils capable of producing vigorous trees, a spacing of 24 by 24 feet, 20 by 2

IGURE 4.—Peach orchard that lacks enough space between rows. This makes spraying, cultivating, harvesting, and other operations difficult and inefficient.

eet, or 25 by 25 feet or more is etter than a spacing of 20 by 20 eet. The wider spacing permits se of tractors and other power-riven machinery for hauling har-ows and spray equipment without lamaging trees and scarring ranches. Where trees are planted n the contour, greater distance be-ween rows permits better tree pacing. Where modern speed prayers and other power equipment re used in only one direction hrough an orchard, trees are some-imes set only 16 to 18 feet apart in he rows.

Trees planted for home use or in ther limited areas may be spaced as lose as 15 feet apart. With the loser spacing, tree growth may be ontrolled by pruning. Pruning will reduce the amount of fruit pro-luced, but many trees may still ield satisfactorily for home use or ocal marketing.

Preparing the Site

On infertile soils it is good practice to use a green-manure crop before planting a peach orchard.

If the site is level or only gently sloping, the soil may be disked or plowed before the trees are planted. Where trees are planted on the contour or where terracing between rows is necessary, only the narrow strips of land for planting the tree rows need be prepared. The land between these strips may be left uncultivated. Often in large peach orchards, a deep furrow is prepared for each row of trees. The furrow is filled after the trees are planted.

When the rows have been laid out for planting, holes are dug for the trees. This digging requires little effort in an area that has been furrowed for planting. The holes should be 18 inches or more in diameter and deep enough to accommodate the root systems of the trees.

Soil augers operated from power takeoff of a tractor are now used for large plantings (fig. 5).

FIGURE 5.—Hole-digging auger used for tree planting. Power is from the takeoff on the tractor.

Details of methods for laying out and terracing an orchard on the contour can be obtained from your local county agricultural agent or Soil Conservation Service office.

Setting Out the Trees

Before planting peach trees, any broken or diseased roots should be removed. Additional root pruning is not necessary or desirable. If the roots have dried out in storage or in transit, they should be soaked in water for several hours, or overnight. Special care should be taken to keep the roots from drying out or freezing while they are being planted.

In setting out a tree, it should be planted 1 or 2 inches deeper than it was planted in the nursery. The space around the roots should be filled with topsoil and the soil tamped. More topsoil should be added if it is available and water if the soil is dry. Nitrogen fertilizer should not be applied to the soil at planting time.

Replanting the Orchard

Growing young peach trees on old peach orchard sites is often unsatisfactory. Some young trees planted on old sites die the first summer after planting. Some survive the first season but make weak growth and die the second or third summer. Growth failure may be caused by nematodes, root aphids, diseases, poor soil drainage, low nutrient supply, low soil pH, or poor tree condition at planting time. Often, however, the reason for failure is not clear. The replanting problem seems specific to peaches. For example, apple or plum trees may follow peach trees in rotation without replanting difficulty, and peach trees may follow apple or plum trees satisfactorily.

Special care of young replanted trees and use of fertilizer, especially nitrogen, in the early summer are sometimes helpful.

At Beltsville, Md., applying about 1 ton of lime per acre to the old field soil has been satisfactory. Fumigating the old field with methyl bromide has also helped. Some root damage to replanted trees, especially in the Southeast, is due to mushroom root rot (*Clitocybe tabescens*). Where nematodes are numerous, especially those of the root-knot type, soil fumigation with Nemagon is helpful. In addition, use of nematode-resistant rootstocks is advisable. More research is needed on replanting because of necessary reuse of good peach sites.

TRAINING AND PRUNING

In the United States, the trend is toward less severe pruning of young peach trees and more severe pruning of old trees. After the scaffold limbs have been selected, the tree should be pruned only lightly until

t starts to bear fruit. Even then, o obtain highest yields of high-uality fruit, pruning should be ery light during the early bearing ears. As the tree grows older and lead twigs appear, the branches hould be thinned and headed back nore severely to vigorous, outward-growing, lateral shoots.

The Young Tree

When planted.—Pruning cuts on he young tree from the time it is et in the orchard to its early fruit-ng years are mainly for training urposes. Early training is neces-ary to obtain a productive, long-ived tree that may be sprayed, hinned, cultivated, harvested, and otherwise handled economically. Not all growers train their trees in he same way because of differences n soil or other conditions. To de-elop a strong, winter-hardy, long-ived tree, the scaffold branches hould be selected and trained to orm wide angles with the tree runk.

When obtained from the nursery, 1-year-old peach tree is usually to 6 feet tall and has few lateral ranches uniform enough to be used s scaffold or framework branches. After the tree is set out, its lateral hoots should be cut back to short tubs having one or two buds each fig. 6). This brings the top into alance with the root system and orces the tree to develop strong hoots, some of which will be se-ected as scaffold branches.

Spring-planted trees should be ut back immediately after they are et out. Where winters are severe, all-planted trees should not be cut ack until late winter or early pring.

The height to which a tree is eaded back depends partly on its ize and how well it is branched, nd partly on the grower's prefer-nce. Also where winds are strong, ow-heading is desirable. Occasion-lly a 1-year-old nursery tree has well-developed laterals that can be headed back to 6 or 8 inches and spaced to form the head. If a low, spreading tree form is desired, the central stems of 1-year-old trees may be cut to a height of 12 to 18 inches if buds are present that low on the trunk. To facilitate cultivation and other necessary orchard work, a higher framework of branches is sometimes preferable. Where trees are headed back to a height of 12 to 20 inches, the scaffold branches are usually close together on the trunk. If the tree stem is about 36 inches long when it is planted, scaffold branches can be spaced farther apart on the trunk.

Nursery trees 4 or more feet tall, with diameters of $\frac{7}{16}$ to $\frac{9}{16}$ inch, have a potentially better scaffold system. They should be cut back to about 36 inches, and their lateral shoots cut back to a few buds (fig. 6). June-budded trees may not be tall enough to need heading back. The terminal cut should be made just above a live bud or a vigorous lateral branch that forms a sharp angle with the main trunk. If the cut is made at a lateral branch, this branch should also be cut back to a vigorous bud toward the outside; and 4 to 6 inches of the branch should be left on the trunk. All other branches that are weak and crooked and that have sharp-angled crotches, should be removed. All branches below the lowest selected scaffold limb should also be removed.

First and second years.—Two to four scaffold limbs should be selected in early summer of the first growing season (fig. 7). Some growers prefer only two scaffold limbs opposite each other and forming a wide crotch about 20 inches high. Others prefer three or four scaffold limbs no closer than 5 inches apart on the main trunk. Furthermore, the scaffold branches should be spaced around the trunk so that

FIGURE 6.—Pruning the young peach tree just after planting. Tree is headed at about 36 inches, and all branches are cut back to short stubs.

FIGURE 7.—New growth on young peach tree about 3 weeks after planting. Scaffold limbs may now be selected and other shoots pinched back. Tree may also be fertilized if necessary.

none is immediately above another. It is essential that these scaffold limbs form and maintain wide angles with the central trunk.

Some summer training is desirable the first season of growth. Shoots arising near the ground can be removed during the summer. Undesirable shoots and lateral branches arising in addition to the selected scaffold limbs should be pinched back by hand or clipped back. Any shoots on scaffold limbs within about 10 inches of the trunk should also be shortened. Cutting back these shoots, rather than removing them entirely, causes wide-angled crotches in the selected scaffold limbs.

If there is no summer training the first season, scaffold limbs should be selected during the dormant period before the second growing season. Training or corrective pruning at this time necessitates removing a large amount of the previous season's growth. All limbs except those selected for the scaffold branches should be removed entirely or severely cut back. The wide-angled limbs selected as scaffolds may need heading back only if they are disproportionately vigorous compared to others. Where summer pinching removed parts of limbs during the previous growing

eason, the entire limbs can now be emoved. Lateral branches on the caffold limbs within a foot of the runk should also be removed.

Early training of wide crotches is ssential to obtain long-lived, productive trees with strong branches ree from winter injury to the rotch.

The topmost scaffold (or modified eader), either as a bud or a shoot imb just after planting, may require further training after 1 year's rowth. Like the other scaffold imbs, it should be trained to grow n an outward and upward direcion. This can best be done by renoving or cutting back all branches ot growing in the desired direction. The purpose of this training is to levelop an open, spreading, symnetrical, and strong tree. Pruning fter 1 year's growth in the orchard s the best time to start training a ree.

Occasionally much of the treetop rows poorly the first season in the rchard. Often a strong, vigorous hoot arises during the summer near he base of the tree above the rafted bud. If this shoot is upight and forms a sharp angle with he trunk, the original top of the ree may be removed just above the ase of the new shoot. Thus, this hoot assumes the position and funcion of a main stem or tree trunk. caffold limbs on this shoot then are elected as described for the original ree after 1 year's growth.

Some peach growers use a deshooting method of summer training during the first season in the rchard. This method is not used s commonly now as it was a few ears ago. Deshooting requires nuch time and care. With this nethod, the tree should be at least feet tall when planted. The tree s first headed to about 38 inches, nd all branches are removed below 4 inches from the tree base. The ther branches are cut back to one r two buds from the trunk. During early summer, when the new shoots are about 6 inches long, four or five of the most vigorous, wide-angled shoots spaced about 6 inches apart are selected. All other shoots are removed.

A modification of this method is to remove only those shoots that will obviously make poor scaffold limbs. This would include removing the very weak shoots, those with narrow crotches, and those growing in the wrong direction. The remaining branches (possibly 8 or 10) are allowed to grow during the first summer, and scaffolds are selected when the trees are pruned the following winter. When using the deshooting method, it is preferable to prune the tree several times during the summer and remove undesirable shoots that develop.

During early summer of the second year, new shoots growing from the trunk should be removed except where one is necessary for a scaffold limb. Only light thinning out of limbs and only occasional cutting back to outward growing limbs are required to obtain a well-opened tree the third year.

The Bearing Tree

The young bearing tree.—After carefully pruning and training the peach tree the first 2 years, little pruning should be necessary for several seasons. A good scaffold system will be well established, and a spreading-branch habit will be encouraged by the weight of the fruit on the limbs. After the second growing season, only light, corrective pruning will be required to keep the center open and the main branches well spaced (fig. 8). The short branches bear the large fruit buds growing near the base of the large scaffold limbs. Where there are a large number of branches, they may be thinned out to permit light to reach the tree center. Not all should be removed, however, since

FIGURE 8.—A 2-year-old peach tree after pruning. Vigorous branch growth is pruned lightly to outside shoots or not at all.

they are usually the first twigs to bear fruit. If they are all removed, the fruit-bearing potential of the tree is delayed unnecessarily.

After fruiting begins throughout the tree, the inside twigs should be thinned out and shortened to prevent shading of the tree center. Shading prevents desirable new shoot growth in the tree head as well as development of highly colored fruits.

A well-trained peach tree will often bear a few fruits the second year, and a peck to a bushel of good fruits the third year. Pruning the fourth and fifth years should still be light enough to train the tree to a spreading, symmetrical shape (figs. 9, 10, and 11). Pruning is not done in the summer, although a small number of shoots may be removed to prevent dense inside growth.

When pruning peach trees, remember that the flowers and fruit are borne on wood produced the previous year. This fruiting wood tends to grow farther out on the ends of the branches each year. Thus it is best to prune every year to keep the trees within bounds and to prevent the branches from breaking. Furthermore, there is no better way to stimulate the growth of the 1-year fruiting wood in the center of the tree than by thinning out and heading back the inside branches (fig. 12).

Peach pruning after the third and fourth growing seasons is mainly correctional. Removing or cutting back branches that interfer

GURE 9.—Strong, wide-angled crotch in a 4-year-old peach tree. This type of crotch is resistant to winter injury and to breakage by weight of the fruit.

ith the upward and outward pread of the main scaffold limbs is ecessary. Emphasis is on light runing and framework develop- ent. Where it is necessary to ead back a scaffold limb to change s direction, the cut should always e made to an outside lateral branch rowing away from the center of ie tree. A 4- to 5-year-old tree runed in this way is open and has uiting wood throughout (fig. 12). When the number of flowerbuds small, as on very vigorous young ees or following winter budkill- g, pruning should be light. If, owever, all flowerbuds have been illed, young bearing trees may re- uire fairly severe pruning to main- in a spreading growth. Because uit crops aid in spreading the anches, young trees with many owerbuds need little or no heading scaffold limbs. No pruning at all ie first 5 to 7 years results in the rgest trees and the highest produc- on during that period. The trees ecome shaded in the centers, how- er, and fruiting wood is confined to the outside and top of the trees. Correct pruning and training during this period develop strong, long-lived, and hardy trees. Only light heading back and moderate opening of the center of the trees are necessary to encourage spreading growth and to admit light.

The mature tree.—Pruning the mature peach tree annually is desirable to keep it relatively low, to encourage well-distributed fruiting wood, and to obtain high-quality fruit. Bearing peach trees are pruned more severely than are apple, pear, cherry, or plum trees. Enough branches must be removed to permit light and air to reach the tree. First remove dead, injured, and weak branches. Then remove enough healthy branches to give the desired spacing of branches. Pruning, however, is only one of several factors that help produce satisfactory tree growth and fruit quality. Other important factors are soil fertility, soil moisture, control of insects and diseases, and fruit thinning.

During a single season, vigorous, well-grown peach trees often develop upright shoots 2 to 5 feet long in the center of the tree. These shoots should be removed entirely; otherwise, they soon shade out the more productive fruiting wood underneath. The more desirable fruiting branches in the center of the tree should usually be thinned out and headed back lightly to a vigorous shoot (fig. 13). Fruiting wood throughout the tree should be thinned out to keep the tree open enough to maintain growth of new wood each year. The amount of necessary thinning out depends on soil fertility, quality of fruit produced, and amount of dead wood in the tree. If the size and appearance of the fruit are poor and there are many dead twigs in the center of the tree, the tree should be thinned out or some branches removed.

757-340 O—65——4

FIGURE 10.—Strong, wide-angled crotches in a 4-year-old peach tree trained to the modifie leader system. Both this system and the system shown in figure 9 develop strong trees.

A peach tree reaches its most economical height when it is 6 to 8 years old. Trees are allowed to grow to 12 to 14 feet in some areas, and only to 7 feet in other areas. Where the soil is deep and fertile and moisture is plentiful, trees may be allowed to grow high and broad. In areas where soil moisture is often limited and soil fertility is low, small, low trees are best for securing annual vigorous renewal wood. The size and height of the tree are sometimes based on local customs; and local methods are used for pruning, thinning, and spraying the trees, and for harvesting the crop. In areas where orchard sites are relatively inexpensive, trees are often headed low in spite of the usually smaller yields produced on low trees. Orchard workers who prune, thin, and harvest fruit from high trees sometimes object to working from stepladders. In general, the most satisfactory tree height is between 8 and 10 feet.

The mature peach tree requires more pruning than does any other fruit tree. Pruning is largely a renewal process and is done by removing upright branches, by thin

FIGURE 11.—Weak, narrow-angled crotch in a 4-year-old peach tree. This tree may split from the weight of its fruit, particularly following winter damage to the crotch.

ning out shoots, and by occasionally removing large branches of 2- to 3-year-old wood. The main branches of mature trees should never be cut back to upright or outward-extending stubs.

The practice of heading back all branches and shoots is not advisable. The renewal pruning method results in an open-topped tree capable of producing high-quality fruits.

By using the renewal pruning method, trees may be kept 8 to 10 feet tall. Only short stepladders are then needed to prune, thin, and harvest the fruit by hand. At this height, the largest branch on each well-developed crotch is removed just above or at the side of an outward branching lateral. This point at the crotch is used as a base for the renewal height (or "renewal point") of the tree top. Two or more branches usually develop the following summer at this renewal point; then all branches except one outward branching shoot are removed at the next pruning. After several years, it is necessary to change the renewal point to one slightly higher or one slightly lower on the lateral. Keeping the renewal points at varying heights helps to prevent a thick-topped tree that shades the lower inside areas.

Usually, too many flowerbuds are produced on the previous season's growth. Thus pruning the newest growth thins the fruit as well as encourages renewal of better new

FIGURE 12.—A strong, vigorous, productive, 5-year-old Redhaven peach tree. Top, before pruning; bottom, as pruning is finished.

FIGURE 13.—A strong, mature Elberta peach tree pruned to about 10 feet high. Growth renewal points are established throughout the tree.

shoots for producing high-quality fruit. New terminal growth each year should be 12 to 15 inches long throughout the mature tree. As the tree becomes older, severe pruning is necessary to maintain the most desirable fruiting wood. Sometimes a fairly large branch on the inside of the tree must be removed completely, and others must be headed back. The presence of short, slender, terminal shoots 6 to 8 inches long probably indicates too little pruning. Conversely, the presence of vigorous, annual shoots 30 to 40 inches long probably indicates too severe pruning. These conditions, however, may be caused by some other factor, such as soil fertility. Pruning, fertilizing, fruit thinning, and soil management must be interrelated to obtain the most productive tree growth.

Rejuvenation pruning. — Sometimes extra-heavy pruning is required on old or neglected trees to make them again bear profitably. There is often a tendency to "dehorn" or "dehead" the old, weak trees in order to rejuvenate them. Tests have shown, however, that trees moderately to heavily pruned made greatest total growth of new wood during the two seasons following treatment. After this moderate to heavy pruning, only a moderate type of thinning out and heading back is necessary at the end of the first season to obtain a well-shaped, spreading tree. Also, for the next several years these trees will require only moderate pruning. Rejuvenation pruning tends to lower the tree head. This greatly facilitates orchard operations and rapid regrowth of adequate fruiting wood.

Sometimes large cuts into the best available 4- to 6-year-old branches are necessary to lower the height of the fruiting wood. The method used for renewing the tops is not well suited to inner tree growth or to controlling tree extension. These are best accomplished by thinning out some branches and heading back others to vigorous laterals.

Although correct pruning will reduce the necessary amount of thinning, propping, and bracing, it will not eliminate the need for such support in years of heavy crops.

Time of Pruning

Experiments have indicated that most pruning should be done during the dormant season. However, where spring frost may injure the crop, pruning should be delayed. Some peach growers do at least a part of their pruning after the blooming period because of frost danger. If frost kills a high percentage of the flowers, little or no pruning is done that season. Of course, this practice is not best for renewing shoot growth of the tree.

Fruit yields are reduced when mature trees are pruned after the full-bloom stage. Pruning at full bloom, at "shuck fall," and even at 3 weeks after shuck fall will produce larger fruit than not pruning at all. Thus it seems that most pruning should be done no later than at full bloom. However, if no pruning has been done, it is better to prune late than not at all. In areas where frost hazard is serious, it may be preferable to prune twice: First, to make major cuts during the dormant season; and second, to thin the blossoms after the frost danger has passed. Pruning after full bloom increases twig growth, number of leaves per fruit, and fruit size. The later pruning is done, however, the less it stimulates shoot growth and the more it reduces the amount of fruit. Spring or summer pruning of mature trees results in little increase in fruit size and often reduced yield.

Pruning tests have shown that no pruning, or pruning done at shuck fall, caused earlier fruit ripening than did dormant pruning or pruning done 3 weeks after shuck fall. Dormant-pruned trees produced the longest shoot growth and the largest number of flowerbuds per foot (table 2).

In the more northern peach-growing sections of the United States, where midwinter killing of buds, branches, and tree trunks sometimes occurs, pruning should not be done until danger of winterkilling is past. Tree injury is often much more severe if the trees have been pruned before the onset of low temperatures. Furthermore, where wood injury has resulted from winter cold, pruning should be delayed until growth starts and the extent of the injury can be determined. Early and heavy heading back, or dehorning, of winter-injured trees may kill some of them. After growth has started, dead limbs can be safely removed. Limbs with live tissues and growing points should be pruned only lightly. Application of nitrogen fertilizer will be more effective in encouraging new tissue growth than heavy pruning of surviving branches that were injured by the cold.

Delayed pruning has advantages when flowerbuds only have been winterkilled, because the percentage of live buds can be determined more accurately after the buds have swelled. Pruning can then be adjusted to the bud set. If pruning is delayed until near blossoming time and few buds have been winterkilled, pruning can be heavier. The number of blossoms and the amount of fruit thinning needed later will be reduced. Pruning, fertilizing, and fruit thinning go hand in hand.

TABLE 2.—*Mature peach trees: Effects of time of pruning on yield, size of fruit, earliness of ripening, shoot length, and number of flowerbuds (Means of 4 years)*

Time of pruning	Yield per tree	Size of fruit	Time of ripening [1]	Shoot length	Flowerbuds per foot
	Bushels	*Number per bushel*	*Percent*	*Inches*	*Number*
Dormant	7. 7	171	22. 0	11. 6	15. 1
Full bloom	6. 2	188	39. 7	9. 7	13. 3
Shuck fall	5. 3	167	43. 9	9. 0	11. 1
Three weeks after shuck fall	4. 7	162	26. 7	8. 7	11. 2
Unpruned	8. 2	214	45. 0	5. 1	10. 4
L.S.D. (0.01)	1. 3	18	15. 3	1. 2	1. 5

[1] Relative time of ripening based on number of fruits harvested at the first 2 of the 4 picking dates.

Pruning in Relation to Fruit Thinning

There must be a balance between pruning and fruit-thinning practices in the peach orchard. Neither practice alone will produce the highest yield of top-quality fruit. Pruning reduces the number of fruits per tree at a time when fruit thinning is of most value—before the fruits have begun to compete with each other and with the growth of the tree.

When a pruning cut is made that removes either the entire limb or a part of it, flowerbuds and leafbuds are removed with the wood. Leafbuds near the pruning cut are stimulated and grow into long, leafy shoots. These leaves are important to the developing fruits left on the tree, since they are the food-producing organs. For largest peach size, there should be at least 35 leaves for each peach. If there are too few leaves per peach, the peaches will be small and the color and quality poor. Unpruned or lightly pruned trees produce more leaves per tree than do heavily pruned trees, although the growth may be short. Unpruned or lightly pruned trees will contain a relatively large number of flowers and young growing fruits, but there will be fewer leaves for each fruit. By the time the fruits are thinned, the potential size will already have been reduced.

Pruning done largely to thin the peaches should be well distributed. Pruning of many small twigs is desirable. Peach trees can quickly disseminate nutrients and food materials. The largest scaffold branches serve as units, so that a large leaf area anywhere on a large branch increases fruit size over the entire branch. Uniform fruit thinning is not necessary to increase peach size.

Pruning in Relation to Fertilizing

In commercial orchards, soil fertilizing and pruning are both necessary for satisfactory new shoot growth on peach trees. Pruning reduces the number of growing points on the tree and increases individual shoot length. Where space is limited and yield of fruit per tree is not a major factor, pruning can keep the tree small and maintain the desired 12 to 15 inches of annual terminal shoot growth of mature trees. Soil fertilization, especially by nitrogen, should be reduced as the severity of pruning is increased. The fruit yield per tree will also decrease with the severity of pruning.

Reduction either in pruning or in nitrogen fertilization results in short shoot growth and early fruit ripening. Fruits of varieties with little red color develop more color with reduced pruning or reduced application of nitrogen to the soil. Fruits of bright red varieties, however, often become dull and unattractive if nitrogen in the soil is low or if the trees are lightly pruned. Heavy pruning delays fruit ripening, as does too much nitrogen fertilizer. Their basic effects, however, are different. Pruning reduces the size and potential yield of the tree, whereas nitrogen fertilization tends to increase both. Heavy pruning often increases the percentage of potassium and other elements in peach leaves, probably by reducing the total leaf area in proportion to the root area per tree.

Pruning Tools and Equipment

The use of the power, compressed-air, or pneumatic pruner in many good commercial peach orchards increases working efficiency and reduces labor costs. The power pruner is most valuable when used on mature trees of uniform size. Some growers find portable platforms are especially useful with this type of pruning operation.

Usually at least one workman prunes from the ground. One of the most useful tools for general pruning is a lightweight lopper-type hand pruner about 24 inches long. This lopper is often the only pruning tool used by many successful peach growers. A small hand shear is also useful for pruning trees. Occasionally, a small saw is used.

SOIL MANAGEMENT

Good soil management is as important for keeping trees vigorous as is pruning. As mentioned earlier, a deep, well-drained soil of medium texture is highly desirable for peach growing. On nearly level orchard sites having this kind of soil and having adequate air drainage, control of soil erosion is not difficult. Soil management on more rolling sites requires careful attention (figs. 14, 15, and 16). To obtain good air drainage, peaches are usually planted on rolling to hilly sites, except in the mild climates of the Southeast, or where lakes give protection from unfavorable temperatures. On these upland sites

FIGURE 14.—Sod strips across the slope in this young peach orchard protect the soil fro erosion.

FIGURE 15.—Low soil terraces across the slope for each tree row help prevent soil erosion.

FIGURE 16.—A sod-mulch system as in this peach orchard prevents soil erosion on the steeper slopes.

The soil is frequently no more than 3 to 5 feet deep. It is customary to cultivate the soil of peach orchards early in the season to make nutrients readily available to the trees. This cultivation conserves moisture by killing weeds and other plants that compete with the trees for moisture. A ground cover of growing plants on an orchard site, however, may serve two important purposes—it supplies organic matter to the soil and it prevents loss of topsoil by erosion (figs. 17, 18, and 19). Tillage practices on any orchard site affect the soil and moisture conservation and the organic-matter content and fertility of the soil.

No fruit trees are affected more by lack of soil moisture and nitrogen than are peach trees. Peach trees root extensively, and the roots of trees planted 20 feet apart may meet after about 5 years. Cultivation breaks down the soil organic matter and thus releases the nutrients. The nitrogen released by cultivation often stimulates the trees as much as does an application of fertilizer. Before inexpensive nitrogenous fertilizers became available, cultivation for this purpose was invaluable. Now, however, it is preferable to add inorganic nitrogen and keep the organic matter on or in the soil as long as possible. This practice will control erosion most effectively, maintain soil porosity, and improve the general physical structure of the soil.

The Young Orchard

The first year after peach trees are planted, the orchard soil should be tended carefully to encourage adequate root and top growth. The soil around the trunks should be kept free from weeds during the growing season, especially in nonirrigated orchards. In the larger orchards, the soil along each side of each row should be cultivated to a distance of at least 5 feet (fig. 14). It is not necessary to cultivate all the area between tree rows. An

757-340 O—65——5

FIGURE 17.—Rye cover crop in peach orchard ready for early spring disking.

FIGURE 18.—Rye cover crop disked down correctly so that much of it remains on the soil surface.

annual or biennial cover crop may be grown on the cultivated strips (fig. 17), and turned under to improve the soil. On sites that are low in soil organic matter and subject to soil loss through water runoff, cover crops in the young orchard are desirable because they check soil erosion and because incorporation of cover-crop residues makes the soil more porous. Cover crops should not seriously hinder growth of the young trees if they are confined to areas well beyond the spread of the tree branches. Avoid deep cultivation.

In orchards on level ground, it is often desirable to grow an intercrop the first 2 or 3 years. The trees are benefited by the cultivation of such a crop and by the fertilizer applied to it. In orchard sites having

FIGURE 19.—Clean cultivation during early summer often results in vigorous tree growth and large-sized fruit, but the soil can erode easily.

slopes, the intercrop should be planted across the slope, so that water collecting in and along the furrows made by tillage tools will not run off rapidly and carry away topsoil. In the second and third years, less space should be allotted to an intercrop than in the first year. Unless the trees are planted at least 25 feet apart in both directions, an intercrop should not be planted after the third year.

The Bearing Orchard

Cover crops.—Bearing peach orchards are cultivated less today than they were 25 to 30 years ago because of the use of cover crops.

Cover crops seeded in late summer that grow during fall or winter are best, because they do not compete with the trees at the seasons when the trees require the most moisture and nutrients. Rye (figs. 17 and 18) is perhaps the most commonly used cover crop for fall and winter. It resumes growing early in the spring and should be disked roughly before it begins to compete seriously with the trees. Sometimes cover crops that winterkill, such as spring oats and millet, are grown during late summer and early fall. Sometimes annual weeds are allowed to grow as cover crops during that period. The crops or weeds are allowed to remain over winter and are disked in early spring. Disking, however, should not be excessive, because it will destroy the value of a cover crop. To permit water penetration and to avoid soil erosion, as much as possible of the cover crop should be left on the soil surface (fig. 18).

In some locations and on certain soils, especially where soil erosion is likely, a summer cover crop such as soybeans, cowpeas, and crotalaria should be grown in addition to a fall or winter crop, even though it will compete with the trees and perhaps reduce the fruit crop. Summer cover crops such as late varieties of crotalaria and buckwheat make most of their growth after the Redhaven season varieties are harvested.

Cover crops should be fertilized according to the local practice. Often a "complete" fertilizer is applied when a cover crop is planted.

Although legumes have often been recommended as orchard cover crops because they add nitrogen to the soil naturally, their use for this purpose is too expensive.

Many commercial peach orchards are not seeded to cover crops, but weeds are allowed to grow in late summer and fall. Sometimes this

system is fairly satisfactory, but a seeded cover crop will usually produce more organic matter for the soil.

Tests to determine the effects of disking rye cover crops at different stages of growth in a peach orchard showed that late disking intensified the red of Elberta peaches but had no significant effect on the color of some of the more highly colored peach varieties. Soil erosion was controlled more effectively by late disking of the cover crop than by early disking. Soil moisture and available nitrogen were reduced by late disking, but not enough to affect the size and yield of the fruit or the growth of the trees.

Where root-knot nematodes are harmful to peaches, nematode-susceptible cover crops such as cowpeas, vetch, rye, and Austrian winter peas should be avoided. Resistant crops, such as crotalaria in the later summer and oats in the winter, may be used. Native weeds allowed to grow during late summer after harvest and disked in midwinter are preferable to a cover crop susceptible to nematodes. Where nematodes are serious and soil erosion is not, clean cultivation throughout most of the year is recommended.

Damage from spring frost during the pink-through-bloom-and-petal-fall period is sometimes reduced by maintaining a hard, bare soil surface. In level peach-growing areas, such as the Coastal Plain, an orchard planted with a cover crop is sometimes 1° to 3° cooler than one without a cover crop. A recently cultivated orchard is just as subject to frost damage as is one planted with a cover crop. Bare, hard soil provides a heat reservoir from which heat is radiated at night. If the soil is covered by weeds, cover crop, or mulch, or if it has recently been cultivated, radiation is impaired. In level areas where spring frosts may occur, orchards are clean cultivated in midwinter or very early spring in time for rains to pack the soil well before frost danger.

Permanent or semipermanent crops.—Sod is sometimes used as a cover crop in peach orchards, but its use is not recommended because it often reduces the growth of trees and fruit. Where abundant water is available from rain, from irrigation, or from an unusually deep soil, a permanent cover is sometimes satisfactory. This is not true, however, in most of the Eastern and Southern States.

The use of soil nutrients by the sod is less serious than its use of water, since nutrients may be added as fertilizer. A nonlegume sod-covered orchard area requires about three times as much nitrogen as one under cultivation, because the soil uses so much nitrogen. A mulch helps conserve moisture in the sodded peach orchard (fig. 16). Peach trees, however, root extensively; and the sod may compete for moisture with roots as far as 12 to 15 feet away from the tree trunk.

Some peach growers use a sod cover but disk the sod well every few years. Others use sod strips across the slope between wide, cultivated peach rows (fig. 14). The sod strips control erosion, and cultivation reduces competition with the trees. The sodded strips provide useful surfaces for moving sprayers and harvesting equipment, especially during wet weather. Orchard sod should be fertilized and mowed occasionally.

In soil-management studies made at Beltsville, Md., over a 12-year period, cultivation of soil in peach orchards during the summer was more effective than use of a summer cover crop. Annual cover crops were more effective than were semipermanent sods of sweetclover or lespedeza. Soil moisture seemed to be the principal limiting factor. Either system of sod culture reduced tree growth and decreased

eld and size of fruits, even in ma-re trees.

Some compromise between a sys-m of clean cultivation and con-nuous use of sod is possible. Shal-w disking two or three times a ar is usually satisfactory. For st results, the needs of each or-ard should be considered indi-dually.

Soil and moisture conservation in ach orchards is very important. ntour planting is often neces-ry, and sometimes terraces are eded (fig. 15). Much depends on e soil type, the amount and dis-ibution of rainfall, and the per-ntage of land slope. Soil and oisture losses are easily over-oked; it is wise sometimes to risk ducing tree growth for the sake soil conservation.

FERTILIZERS

There are 12 known nutrient ele-ents necessary for plant growth. he major nutrient elements, or acroelements, needed by peach ees include nitrogen, potassium, hosphorus, magnesium, and cal-um. The minor nutrient ele-ents, or microelements, include nc, boron, maganese, copper, on, sulfur, and molybdenum. A inor element is just as essential as major one, but less of it is re-uired.

Nitrogen remains the chief fer-lizer element needed by peach or-ards on most soils. Potassium is erhaps the next element most eeded. The elements most needed, nd the rates at which they should e applied, vary widely according soil type and other factors.

A fertilizer program should be lanned to cover the complete life f the orchard. A balance of all utrient elements, but especially of itrogen, potassium, and mag-esium, is important. However, nly those materials needed by the rees that are not supplied by the soil should be added. Usually fertilizers are applied to the soil, but some may be applied to the tree as foliar sprays.

Nitrogen

Nitrogen deficiency symptoms are small, pale-green leaves, sometimes yellow with red specks; short, thin shoot growth; and small, early-ripening, highly colored fruits. Lack of nitrogen absorption and translocation because of root or limb damage or poor soil drainage also produces these same symptoms.

For satisfactory tree growth and production, nitrogen should be added to soils in all peach orchards east of the Rocky Mountains. The amount needed varies considerably.

To obtain high-quality peaches, the soil nitrogen level should be neither extremely high nor extremely low. The level may be regulated somewhat by the use of cover crops as well as by the amount of nitrogen fertilizer applied and the time of application. For the brightest fruit color, the soil nitrogen level should never be extremely high. Where color is important, the nitrogen necessary for tree growth should be applied in the fall rather than in the late spring or early summer. The effect of nitrogen on color is important in such varieties as Elberta, Sullivan's Early Elberta, and Belle; but Redglobe, Dixired, and certain other varieties color well when relatively high soil and tree nitrogen are present. The time when nitrogen is available to the tree roots is the critical factor; this depends partly on when enough water is available to carry the soluble nitrogen to the roots. Treatments that supply abundant nitrogen in midsummer should be avoided.

A high soil nitrogen level in early spring is necessary for vigorous foliage growth and large peaches, but high available nitrogen in late spring delays fruit ripening.

In some orchards, nitrogen is the only fertilizer needed. Because the amount needed varies greatly, no specific recommendation can be made. Growth of the tree, together with yield, size, and quality of fruit, is the best criterion to determine required amounts of fertilizers, especially nitrogen. A suggested amount would be one-eighth of a pound of actual nitrogen per year of the tree's age, up to 1 pound per tree. For example, the 8-year-old tree would receive 6 pounds of nitrate of soda (16 percent nitrogen), 3 pounds of ammonium nitrate (33 percent nitrogen), or 2.2 pounds of urea (45 percent nitrogen). These nitrogen sources may be selected on the basis of availability and economy, since all are equally effective. High-nitrogen fertilizers are soluble in water and will penetrate to the tree roots soon after rain or irrigation.

The fertilizer should be spread evenly under the tree and should extend just beyond the tips of the branches. Cover crops are improved if the fertilizer is spread over a wider area throughout the orchard, but more fertilizer will be required per acre. A complete fertilizer is necessary in some areas. One pound of actual nitrogen is obtained in 10 pounds of a 10–10–10 fertilizer. Careful observation and advice of local extension or experiment station workers will help determine whether the phosphorus and potassium contained in such a fertilizer is economical.

Foliage sprays containing nitrogen for fertilizing peaches have been tested with little success. Peach leaves evidently do not absorb the nutrient as efficiently as do apple leaves.

Some successful peach growers apply nitrogen only in the late summer or fall. Others apply all the nitrogen early in the spring. Still others apply part in the fall and part in the spring. The loss of fruit color resulting from the second method depends on the variety, the soil type, and the amount of nitrogen used. With a potentially highly colored variety, a sandy soil and a moderate amount of nitrogen there may be no reduction in fruit color.

Tests with Elberta, Halehaven and Triogem varieties at Beltsville, Md., emphasized the interrelation of variety, time of nitrogen application, and time of disking the cover crop.

When nitrogen was applied to trees in the fall, the fruit yield was reduced and the fruit ripened earlier than when it was applied in the spring, or when it was applied in three equal amounts in the fall, the spring, and the early summer. Yields were usually highest when nitrogen was applied in three equal amounts. The time of disking the rye cover crop had little effect on fruit yield of any of the three varieties studied. A full crop of Elberta peaches yielded more than did Halehaven or Triogem. Differences in fruit size due to fertilizer and disking treatments were not consistent. The Triogen peaches, however, were consistently smaller than those of the other two varieties. Fall fertilizing and late disking resulted in the deepest red skin color of Elberta peaches. The treatments did not seem to affect the color of Halehaven and Triogen peaches.

Fruit ripened earliest when fertilized in the fall, but time of ripening was unaffected by disking time. The leaf-nitrogen content in August was greater when fertilizer was applied in the three equal installments than when it was applied in the fall. Time of disking the rye did not affect the nitrogen content of the leaves, which was relatively high regardless of treatments.

The divided applications of nitrogen are especially useful on sandy soils subject to rapid leaching

moisture and nutrients. Also, vided applications allow for bet- r nutrient management based on op needs. For example, if the uit set after bloom is heavy, more trogen can be applied than if ere is a light set following a severe ost. In the southern areas, at ast part of the annual nitrogen quired can be applied just after arvest. However, in the northern eas, nitrogen applied after har- st may increase winter injury.

otassium, Phosphorus, Magnesium, and Calcium

There is almost as much potas- um as nitrogen in peach leaves. n many peach-growing areas, trees et as much potassium as they need ithout fertilizing. In some areas, ich as much of the Atlantic oastal Plain extending from New Jersey to Florida, trees often require additional potassium. In other areas, the need for potassium fertilizer for peaches varies. Severe potassium deficiency causes slender shoot growth, and rolling, puckering, and marginal burn of leaves (fig. 20). Mild deficiency, however, reduces fruit size and yield. In early spring, potassium may be applied to the soil surface under the tree at the rate of 2 to 4 pounds of either muriate or sulfate of potash. It can be applied also in a complete fertilizer such as 10–10–10.

Phosphorus in peach-orchard soils is often low, but it is rarely necessary to add any for the peach tree. Peaches, as well as other fruits, are able to obtain the phosphorus they require where annual crops will show a severe need for phosphorus fertilization.

IGURE 20.—Potassium-deficient peach leaves. Left to right: Leaves with increasingly severe symptoms of potassium deficiency.

Magnesium deficiency in peaches (fig. 21) is found mainly in the sandy Coastal Plain soils, especially following heavy potassium fertilization. The first indication of this deficiency is a light yellowing between veins of the leaf. In severe cases, death of the yellowed areas is accompanied by a marginal leaf burning. Usually the more basal leaves are affected first. Foliar spraying with about 10 pounds of magnesium sulfate (Epsom salts) per 100 gallons of water usually gives prompt control. Application of dolomitic limestone to the soil at about 2 tons per acre will often control the deficiency within a fe years.

Calcium is sometimes needed as fertilizer for peaches, especially Coastal Plain soils where lar amounts of sulfur have been used spray peaches for disease contr Calcium reduces soil acidity, ar this, in turn, increases the availabi ity of many soil elements and ro growth (fig. 22). Although pea trees grow well in acid soils, the p should not be below about 4.5. Ve high soil calcium reduces absorptic of potassium and magnesium by t roots. Soil acidity can be correcte

FIGURE 21.—Left to right: Increasingly severe symptoms of magnesium deficiency in peac leaves.

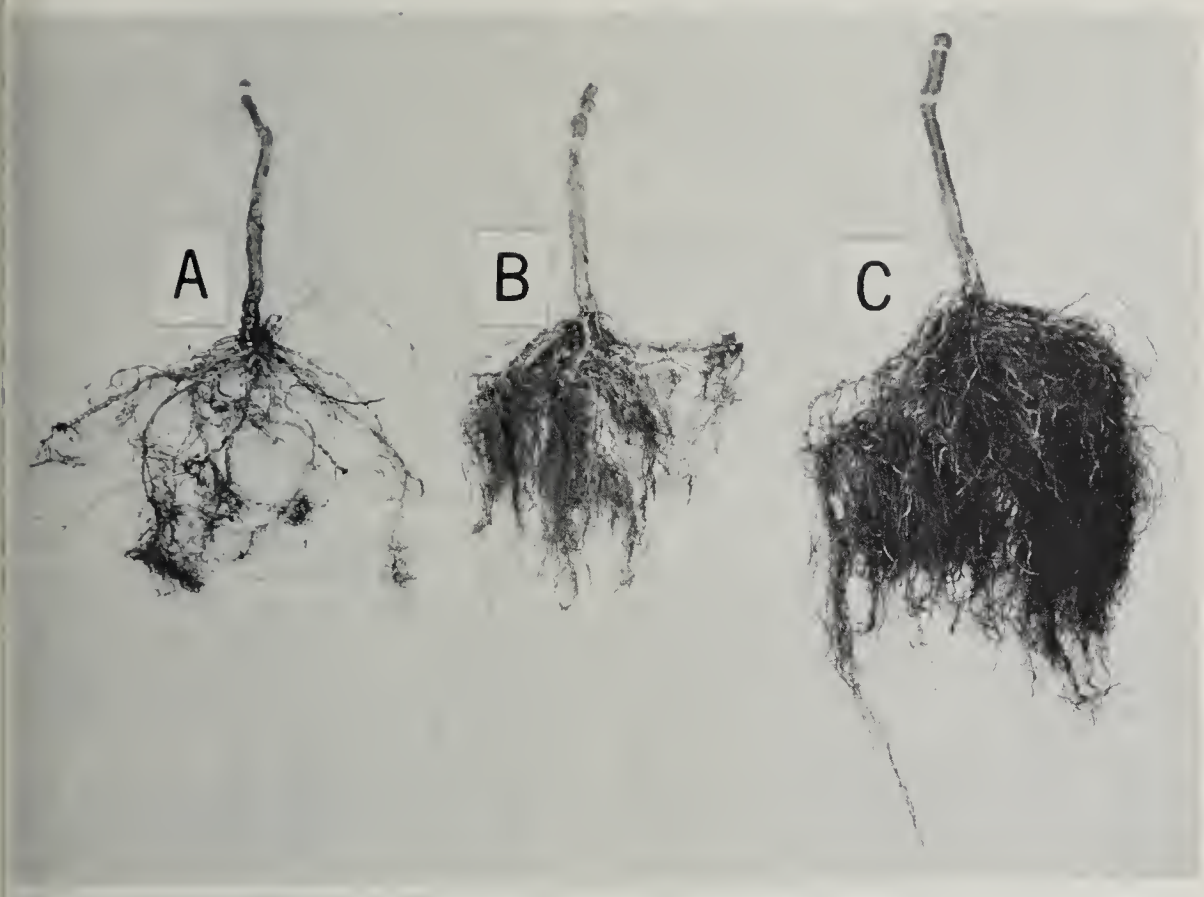


FIGURE 22.—Effects of (A) low, (B) medium, and (C) high levels of calcium on peach roots grown in orchard soils at Beltsville, Md.

by adding limestone according to local recommendations.

Zinc, Boron, and Manganese

Zinc deficiency sometimes occurs in peach trees grown in sandy soils of the Carolinas and Georgia, but it is much more common in the Western States. Symptoms of this deficiency are light yellow, wavy, and crinkled leaves, with rosettes at the tips of the twigs. In severe cases of zinc deficiency, leaves are very small.

Boron deficiency causes twig death, lack of bud growth, and sometimes dark-brown cork spots in the fruits. It occurs only occasionally in Eastern United States.

Manganese deficiency causes light-yellow areas between the veins of the younger leaves toward the tips of the shoots. Deficiencies in all these microelements can usually be corrected by foliar sprays used according to local recommendations.

Copper, iron, sulfur, and molybdenum usually occur in ample quantities in most orchard soils.

All the chemicals mentioned are assumed to be caustic and poisonous; some are flammable. They should be kept dry and handled with care to prevent fire or explosion.

IRRIGATION

Many peach orchards east of the Rocky Mountains are now irrigated. Increased efficiency in pumping and sprinkling equipment has aided greatly in making orchard irrigation economically practical. Many

successful peach growers in the East now consider irrigation an essential part of their soil management program. Irrigation is planned and used according to needs of the trees and capacity of the soil.

A short period of dry weather, especially during the final month before harvest, will sharply reduce fruit size and quality of peach trees growing in shallow soil. Low soil moisture during early summer affects fruit size and yield and also affects next year's crop by reducing the terminal growth of shoots and by weakening the trees. Peaches from irrigated trees ripen a few days earlier and ripen more uniformly than do those from nonirrigated trees.

In most of the Eastern United States, winter rains fill the soil to its maximum water-holding capacity by spring. Thus, peach trees start the growing season with adequate moisture. The amount of water the soil can hold depends mostly on soil texture and depth. This varies from about 1 acre-inch of water per foot for sandy-loam soils to about 2 acre-inches per foot for clay loams. Thus, if the root-depth zone is 4 feet in a silt-loam soil, there will be about 6 acre-inches of water available in the spring. Eastern peach orchards use about 3 acre-inches o water per month during the grow ing season. Thus, the available soi water would last about 2 month without additional rain. Peacl trees need water most during th month just before harvest, when th moisture requirement for fruit siz is greatest.

Development of a water supply and cost of equipment and mainte nance are expensive. Irrigatio will be least economical where th root depth is great, the soil is fairly heavy, and an early ripening peacl variety is grown. But where a good supply of water is available a moderate cost and the root depth i as shallow as 2 to 3 feet, irrigatio should increase peach production i most years.

If rainfall has averaged less thar 1 inch per week for about 3 weeks irrigation may be needed, espe cially close to harvesttime. Wher irrigating, completely wet the soi to the root depth. Light, sandy soils may lose nutrients because o too much irrigation, but they nee more frequent irrigation than d heavier soils. Irrigating any soi too much or too often can damag peach tree roots. Learning to irri gate properly requires careful study and much experience.

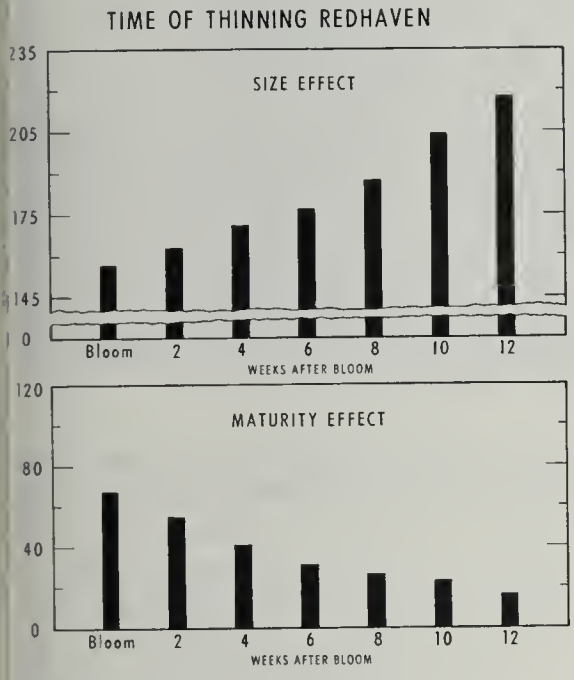
THINNING THE FRUIT

Fruit thinning is necessary to produce high-quality peaches, especially in years of heavy crops. The extent of thinning depends somewhat on the potential size of the mature fruit of the particular variety. In general, the smaller the normal size of the fruit at maturity, the wider the spacing to which the fruit should be thinned on the twigs. The correct thinning distance depends partly on the leaf area per fruit and the general vigor of the tree. It takes about 35 healthy, average-sized green leaves to produce a peach of good size and quality. In thinning, only one peach should be left to every 6 o 8 inches of twig. Although this may seem drastic and expensive, it must be remembered that small peaches are often hard to sell. Also, thinning lessens the harvesting work and the danger of limbs breaking under the weight of fruit.

Thinning According to Variety

With the early ripening peach varieties that tend to set a heavy load of fruit, thinning well before the June drop greatly increases

uit size and earliness of ripening ig. 23). These early ripening rieties have a much shorter period fruit development than do El-rta and the later ripening varie-es. Varieties that particularly nefit from early thinning include ayflower, Earlired, Cardinal, oronet, Redhaven, Golden Jubilee, nd Triogem. With these early pening varieties, early thinning of uit increases not only fruit size t also quantity of young-shoot rowth and leaf size.



GURE 23.—Effects of time of thinning on fruit size (top) and maturity (bottom) of Redhaven peaches. Each successive thinning period caused smaller and later ripening peaches.

For many early ripening varie-es, if thinning is delayed much fter the pits begin to harden, the nal size of the fruit may not be reatly increased. This is espe-ially true if dry weather prevails uring the early part of the grow-ng season and at harvesttime. rowers must determine if the reater value of the larger fruits ustifies the expense of early hinning.

With midseason and later varie-ies, the usual practice is to wait until after the first drop and then remove many of the small and imperfect fruits. Experiments with Elberta peach trees have shown that if the fruit set is only moderate and the drop in June is fairly heavy, thinning done as quickly as possible after the June drop usually results in fruits of good size and color. If thinning is delayed until well along in the pit-hardening period, it still has a beneficial effect on the final size of the fruit. If thinning is done as late as the period of final swell, it still increases the size of the remaining peaches.

Elberta trees bearing a large crop should be thinned just as soon as possible after the first drop. When thinning is done quickly near the end of the first growth period (before pit hardening), the result is almost as satisfactory as it is with earlier thinning. The cost is much less, because some of the peaches will drop anyway.

Amount To Thin

How many peaches should be removed from a tree by thinning depends chiefly on the size of the tree and its bearing capacity. If a tree cannot bear more than 1 or 2 bushels, only enough of the peaches that can develop to desirable size (those with a diameter of 2¼ to 2½ inches) should be left to make up this quantity. When a tree has a uniformly heavy set of fruit, it can be thinned to a fixed spacing, such as 6 to 8 inches along the twig. Usually, it is best to thin not according to a fixed spacing but according to leaf area, tree vigor, and bearing capacity. After a spring freeze, sometimes the only blossoms left alive are those at the bases of terminal shoots. When this happens, the fruits are not thinned even where they touch each other, because the leaf area is sufficient for all.

Methods of Thinning

Where labor costs are high, peach growers may choose to reduce the number of peaches that will be produced on their trees by pruning off a large number of shoots either before or at blossomtime. In localities where spring frosts occur, some detailed pruning may be postponed until blossomtime, when crop prospects are more certain.

Recently, because of high labor costs, considerable thinning has been done by rapid mechanical methods rather than by the older hand method. Some growers now use poles 4 to 8 feet long or longer, with about 12 inches of hard rubber hose over one end. With such poles, the excess fruits are removed by tapping the branch or twig first at right angles and then lengthwise. Wire or brush brooms are sometimes used to thin peach blossoms, especially those of early ripening varieties.

Several types of chemical sprays have been tested, some of which thin late and after danger of frost. However, none is dependable enough to be recommended for practical use. Elgetol is one of the chemical thinning sprays that has been used extensively, although its results are not always reliable. If Elgetol is used, spraying should be done at full bloom. The suggested strength is 1 pint of Elgetol per 100 gallons of water.

Blossoms should not be thinned by any method if it is likely that some may be killed by frost. The most experienced growers prefer to do only part of a necessary thinning by mechanical methods and then to follow up with hand thinning.

LOW-TEMPERATURE INJURY

Low-temperature injury is one of the greatest problems of peach growers in both the North and the South. Almost every year, serious winter injury of peach trees occurs in one or more sections of the country (fig. 24). Often winter injury is not recognized as such, for it can occur when temperatures have not been unusually low. For example, rapid drops in winter temperatures from about 70° F. during the day to about 18° F. at night have caused severe damage to peach tree wood in southern areas. In northern areas, the damage is likely to occur only at much lower temperatures; and dormant flowerbuds are affected before the wood is. A rapid drop to temperatures below −15° F. often injures twigs and trunks as well as buds. Sometimes, in peach orchards having no ground cover, prolonged low temperatures damage even the tree roots.

In both northern and southern peach-producing localities, winter injury seems to be least among moderately vigorous trees that grew well the previous season and that were not weakened by poor drainage, loss of leaves, borers, nematodes, or other factors.

Injury to Buds

The most common type of winter injury to peaches in the Northern States is killing of dormant flowerbuds. Leafbuds are seldom injured. There is no fixed minimum temperature at which dormant flowerbuds are destroyed. Much depends on the tree growth during the previous growing season, age and vigor of tree, variety, state of flowerbud development, rapidity of temperature drop and time of its occurrence, and duration of the low temperature. During midwinter, the critical low temperature for Elberta peaches is about −10° F. However, a rapid drop in temperature after a warm period can lead to budkilling at temperatures much higher than −10°. Conversely, buds have some-

IGURE 24.—Winter damage, primarily on the southwest side of the tree trunk and lower parts of scaffold limbs, caused by rapid temperature changes. Reflection of sun by snow causes surface temperatures considerably above air temperature.

imes survived temperatures below -15° in midwinter when the drop vas slow and when it followed a eriod of relatively cold weather.

Differences in flowerbud hardiess between peach varieties sometimes mean the difference between good peach crop and no peach rop. Elberta and J. H. Hale are wo of the more tender varieties. Rochester, Veteran, Cumberland, nd Erly-Red-Fre are among the nore hardy varieties. Halehaven, Golden Jubilee, and Redhaven may e classed as fairly hardy. Some arieties such as Ranger, Redhaven, nd Cumberland often bear fair-to-ood crops after large percentages f the buds have been killed, beause they characteristically have arge numbers of buds per foot of wig length. Some varieties have o few buds that killing even a small ercentage may make a good crop mpossible.

Usually there is greater bud mortality on trees having weak growth. Even where there is some difference in tree growth because of different fertilization, however, there is often little or no difference in bud survival during midwinter.

In many parts of the country, especially in the Central and Southern States, damage often results from low temperatures during or after bloom. As flowerbuds develop in the spring, they quickly become more sensitive to cold. Just before they open, flowerbuds will survive temperatures of about 20° to 23° F. The lowest temperature flowers will withstand at full bloom is about 26°. Ten days to 2 weeks after bloom, they will withstand only about 28°. Buds and flowers will survive temperatures slightly lower than these if the drop is very slow and if the minimum temperature continues only for a very short time.

Accurate thermometers should be used in the orchards. Early spring temperatures, especially on hillsides, are not uniform even at points only 50 feet apart. The higher part of a sloping site is usually much warmer than is the lower part, since cold air drains downward. A 50-foot difference in elevation on a hillside may mean a difference of as much as 5° F. in minimum temperature on a still night.

Injury to Twigs, Branches, and Trunks

Even in some of the most southern peach areas, and during mild winters, wood killing is often serious. Injury is caused by rapid drop in temperature and by immaturity of new wood growth produced in late summer or early fall from the stimulation of high soil nitrogen content, recent heavy pruning, or other factors. Peach trees develop resistance to cold only if they are exposed gradually to low temperatures. Trees that have grown poorly for any reason are especially subject to winter injury to trunks and branches. Weak growth and the resulting winter injury are caused by poor soil drainage, nematode injury to roots, low soil fertility, insect damage, and disease. The critical temperature at which wood injury may occur is not specific. Serious trunk damage has resulted from −20° F. temperature in northern areas during certain years. In both northern and southern peach-growing regions, the least low-temperature damage seems to occur in trees of moderate vigor and where there are no sudden chang in temperature.

Even though wood appears have been damaged by winter co much of it may survive if the tr are not pruned too early or too s verely and if readily available n trogen is applied to the soil at somewhat heavier than usual ra If bark on the trunk is found to loose after a severe drop in te perature, it should be tacked place immediately. This som times prevents the bark and wo from drying out, and it may hast healing. When large branches trunks have been severely damage the injured parts should be paint with a standard tree paint—whi lead and raw linseed oil, or a liqu (brush) grafting wax.

Injury to Roots

Cold injury to peach tree roo is often overlooked or disregarde Winter injury to roots is usual more severe in light, sandy soils a after prolonged cold. It is mu worse where there is no snow other covering on the groun Cover crops are valuable in prever ing this type of injury. In add tion to directly insulating the roo from cold, cover crops tend to ho protective snow in place. After s vere damage to roots, tops should given a moderately heavy prunin

Although freezing of orchard so may not kill tree roots, it may r tard their absorption of water du ing the winter. Trees grown light, shallow soils in more nort ern States are, of course, most like to be injured by soil freezing.

HARVESTING, TRANSPORTING, AND STORING FRUIT[6]

The peach grower's choice of a time to pick his crop depends largely on how he intends to market it. The current trend is to pick more mature peaches than former because their eating quality is be ter. If peaches are to be trucked nearby markets, they may be a

[6] This section was originally prepared by M. H. Haller. Revised by W. H. Red and W. L. Smith, Jr. Market Quality Research Division.

owed to become nearly ripe on the rees. For shipping greater dis-ances, most peaches are picked in he firm ripe stage and precooled ›efore shipment. During transit, his fruit should be maintained at ›r below the precooling temperature o delay ripening and thus reduce ›ruising. Because peaches mature nevenly, it is usually advisable to make several pickings, beginning with the largest, best-colored fruit. For freestone varieties, standards of naturity are based on the change of ground color from green to yellow nd on flesh firmness, as determined ›y using a Magness-Taylor pressure ester (fig. 25). Elberta peaches esting 10 to 14 pounds with a 5/16-nch-diameter plunger applied to he pared cheeks will hold up in re-rigerated shipment for several lays and will ripen with satisfac-ory dessert quality. For nearby narketing, less firmness may be de-irable. About the same range in ›ressure testing is satisfactory for nany varieties other than Elberta.

Drop-bottom picking bags are ıow widely used for peaches. Padded, drop-bottom picking buckets (fig. 26) afford greater protection from bruising. Pickers should exercise great care in handling peaches to avoid bruising the fruit and breaking the skin. They must be careful not to drop fruit, either when placing it in picking buckets or bags or when transferring it to field crates. Picked fruit should be left in the shade of a treé until it can be hauled to the packinghouse.

Tub baskets, particularly the ¾-bushel size, with vented liners and cushioning pads are the most commonly used shipping containers for eastern peaches. However, they have these undesirable features: Peaches in the bottom, especially if they are ripe and soft, are likely to be bruised and mashed by the weight of those above them; peaches on the top are often cut and brused by the rim of the lid; and tub baskets are not rigid and do not stack well. Peaches in these baskets are usually "faced," which adds considerably to the cost. To meet the demand of "nonfacing" and to try to reduce bruising, a new type of tub

FIGURE 25.—Pressure tester used to determine maturity of peaches.

FIGURE 26.—Harvesting peaches in a drop-bottom picking bucket designed to prevent bruising.

basket, the "flat-top" or "Pallet-Pak," also has been widely tested. This basket has no handles. The sides are raised and the lid is placed so as to prevent the normal bulge present in the conventional tub basket. Stacking quality is improved, also.

Wirebound crates have been tested, and some are gaining popularity in many areas. The advantage of these containers over tub baskets, is that fruits are packed in bulk without "facing," which reduces the cost of filling. Some reports indicate there is less bruising in these containers than in tub baskets. The Spartan wirebound crate was the first of this type of container tested. Although it was once used extensively, its present use is limited. The Du-All, another type of wirebound crate, has the sides and bottom lined with chipboard. The ends and a partial telescopic cover are made of paraffin-impregnated fiberboard. At present, the Du-All is second only to the tub basket in popularity as a peach-shipping container.

Fiberboard cartons with telescopic lids also have been extensively and, in some areas, successfully tested. Most of these containers however, will not withstand hydrocooling. To eliminate the effects of wetting the fiberboard cartons currently in use, many growers are hydrocooling the fruit in field boxes or in bulk hydrocoolers before packing in shipping containers.

The use of paper or plastic cup trays in fiberboard cartons is becoming increasingly popular for shipping large and fancy peaches. These trays also reduce transit bruising of softer fruit harvested at a riper stage. Such fruit requires precooling before packing in these trays.[7]

At the high outdoor temperatures that prevail during the peach-marketing season, picked fruit ripens rapidly. Peaches picked at the shipping stage of maturity become eating ripe in 2 to 4 days at temperatures of 70° to 80° F. Ripening proceeds about half as fast at 60° as it does at 70° to 80° and about half as fast at 50° as at 60°. At 60° and above, peaches ripen with good aroma and flavor. If they are held at 50° until ripe, the flavor is undesirable. At 40°, ripening proceeds about half as fast as at 50°, and the peaches usually break down internally before they become fully ripe. Temperatures of 36° and 32° hold ripening practically at a standstill. After being exposed no longer than 1 week to 50° temperature or lower, peaches will ripen normally at room temperature. After exposure for 10 days or longer to temperatures between 36° and 50°, peaches are likely to break down internally or to become mealy or off-flavored if ripened at room temper-

[7] For detailed instructions on grading and packing peaches, see U.S. DEPT. AGR 1960. PREPARING PEACHES FOR MARKET. Mktg. Bul. 9, 21 pp., illus.

ature. Peaches can be held somewhat longer at 32° than at 36° to 50° without losing the capacity to ripen normally when exposed to ripening temperatures.

Peaches are sometimes stored for short periods to extend the marketing season and the commercial canning season. Fruit that is to be stored should be cooled to a temperature of 31° or 32° F. promptly after picking. Even under the most favorable conditions, peaches cannot usually be stored longer than 2 to 3 weeks. Loss of the capacity of stored peaches to ripen with good dessert quality and without breakdown cannot be readily determined by casual inspection. The proper time for bringing fruit out of storage and marketing it must be determined by experience with the variety. The storage life of J. H. Hale peaches cooled promptly to a temperature between 31° and 32° may be 3 or 4 weeks. That of Elberta, Redhaven, and Golden Jubilee peaches similarly cooled is 2 to 3 weeks.

Peaches freeze at about 30° F. To allow for cold spots in the storage room and to provide a margin of safety, peaches should not be held in a room with an air temperature lower than 31° or 32°.

Because of the influence of temperature on ripening, peaches should be moved to market rapidly and under the coolest possible conditions. However, if they can be delivered to market the morning after they are picked, an unrefrigerated truck is usually satisfactory. Nearly all peaches harvested in the Southeast and a great many in the East and Middle West are now being hydrocooled before shipping. Most peach hydrocoolers are ice refrigerated, but the use of mechanical refrigeration is steadily increasing. The hydrocoolers are installed in the packinghouses as part of the packing lines. Peach containers are moved through the hydrocooler under a flood of cold water (fig. 27). The water should be maintained as close to 32° as possible by proper refrigeration. The rate of cooling is affected by size and initial temperature of the fruit, by water

IGURE 27.—Typical peach hydrocooler in operation. (Courtesy of Food Machinery and Chemical Corporation, Lakeland, Fla.)

temperature, and by time in the cooler (controlled by varying the conveyor speed). Fruit temperatures can be reduced 20° to 30° in 10 to 15 minutes. Wooden containers, such as wirebound crates and baskets, are satisfactory for hydrocooling. But, as previously stated, fiberboard cartons must be treated or made of moisture-resistant materials to successfully withstand wetting. Bulk hydrocoolers have recently become available and are being used to a limited extent, usually when peaches are to be packed in the plastic cup trays or in fiberboard boxes.

Ice-refrigerated trucks or trailers used for shipping peaches should be equipped with proper air circulating fans or blowers. They should have floor racks or stripping, and all doors and vent covers should be fitted tightly to minimize air leakage. Floors should be cleaned before loading. From 1 to 3 inches of insulation is necessary. Enough ice must be maintained in the bunkers to insure a temperature of 50° F. or lower during transit. Fan-equipped refrigerator cars should be used and moved with the fans in operation. When a car is held on track at destination for more than a few hours, electric hold motors should be attached to operate the fans. Fan operation will maintain more uniform load temperatures and prevent undue ripening that would occur in warm spots in the load.

Mechanically refrigerated cars and trucks are more desirable because they provide better control of transit temperatures than do ice-refrigerated vehicles.

In areas where hydrocooling is not available, peaches should be room precooled or precooled in ice-refrigerated cars by operating car fans with special electric precooling motors or by the use of portable precooling fans installed temporarily in the top bunker openings. Up to 4 percent of salt should be adde to the ice to increase the cooling rate. Such car precooling may b done to advantage only if facilitie are available for replenishing th ice in the bunkers promptly afte precooling, in order to maintai during transit the low temperature established by the precooling Portable, mechanically refrigerate units may also be used for precool ing in cars or trucks. By these dif ferent methods, it is possible t lower the average temperature of load of peaches about 20° to 25° F in 5 or 6 hours.

Warm peaches loaded in mechan ically refrigerated cars or in th new thermostatically controlle ice-refrigerated fan cars with con tinuously running, power-operate fans may be cooled in transit with out being held on track at loadin point for precooling, as is require with conventional ice bunker fa cars. Since mechanical cars ar usually not designed for rapid cool ing, it takes from 18 to 36 hours t reduce the fruit temperature to 50 F. However, with proper thermo stat setting, lower temperatures ca eventually be reached and main tained in transit in these cars tha can be obtained in the conventiona iced car.

In most peach-producing region the development of decay durin marketing is a serious problem, par ticularly in seasons when rainfa and humidity are high at or nea the harvest period. The two prin cipal decays of peaches are brow rot and rhizopus rot (fig. 28). Bot decays are caused by fungi. Brow rot occurs chiefly in the orchard and how much brown rot occurs i peaches after harvest depend largely on how well the rot has bee controlled in the orchard by spray ing and sanitary measures. Indica tions also are that, unless the hydr cooler and hydrocooling water ar kept clean, the hydrocooling opera tion may serve as a method of inocu lating peaches with spores of th

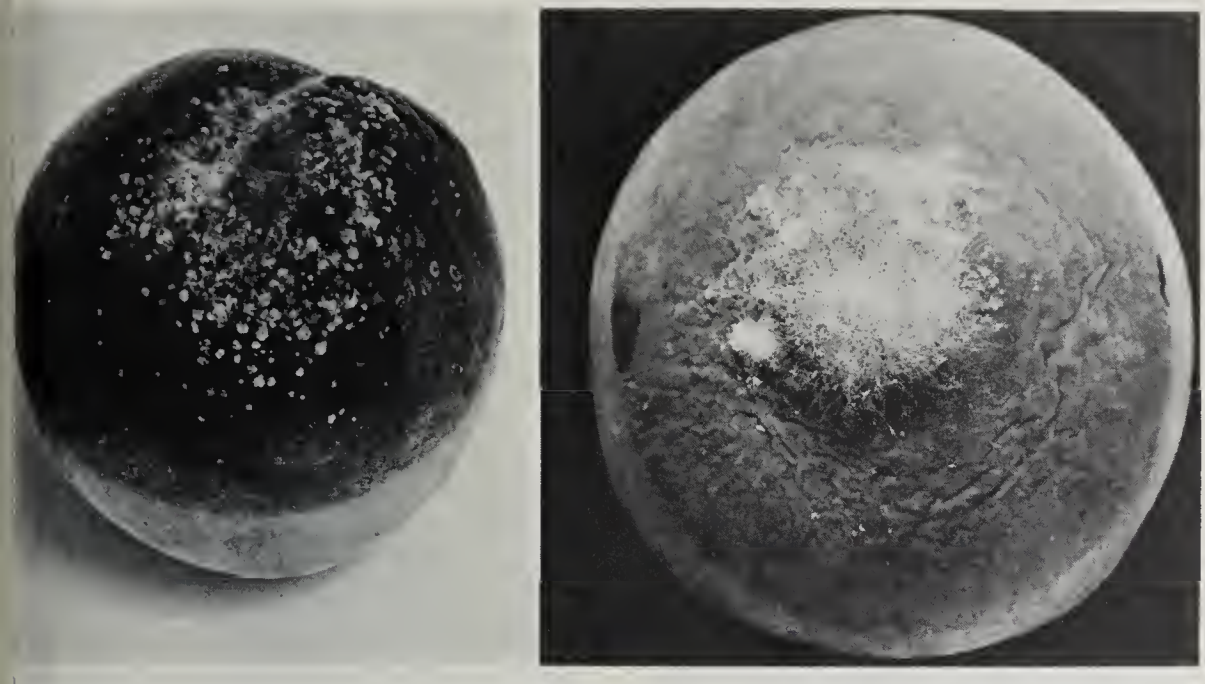


FIGURE 28.—Postharvest decays of peaches. Left, brown rot; and right, rhizopus rot.

rown rot and rhizopus rot or-anism. Rhizopus rot usually oc-urs during harvest, in packing-ouses, or in transit. At tempera-ures of 60° to 80° F., both brown ot and rhizopus rot develop and pread rapidly. Both can usually e checked by cooling the peaches as oon as possible after harvest and eeping them at temperatures below 0° throughout the marketing pe-iod. Since ripening also is re-arded by these temperatures, there ust be some point during market-ng or after the peaches reach the onsumer when they must be ex-osed to temperatures high enough o ripen them. At such tempera-ures, decay will develop rapidly. herefore, although low tempera-ures during transit and marketing ay make it possible to market the uit before decay becomes serious, ey do not reduce the total amount f decay that can develop in the uit by the time it has been ripened ough to eat. For this reason, her means of controlling decay are ecessary.

During hydrocooling, the ice-ater treatment by itself only tem-orarily slows the growth of decay-roducing organisms. To prevent the increase of these organisms in the hydrocooling water, chlorine in the form of calcium or sodium hypochlorite at concentrations of 100 to 120 parts per million is usually added to the water. However, this chemical is not very effective in preventing the development of brown rot originating from orchard infection. The effectiveness of this chemical in preventing a buildup of organisms in hydrocooling water is greatly reduced if the hydrocooler and the hydrocooling water are dirty. Other chemicals that effectively reduce these rots have been found, but no satisfactory method of applying them commercially has been developed.

Recent tests have shown that both brown rot and rhizopus rot were effectively reduced when peaches were treated in water at 130° F. for 2 to 3 minutes. The use of hot water to reduce these decays, however, is still in the experimental stage, although it was used successfully in one packinghouse in 1963 and 1964. The temperature of the water and the length of exposure are critical. A long exposure or water temperature much above 130° may

seriously injure the fruit. Skin mottling of some varieties occurred even with the recommended treatment. Therefore, low temperatures are still the most effective means presently available for delaying the development of decay during marketing.

DISEASES CAUSED BY FUNGI AND BACTERIA [8]

The principal fungus and bacterial diseases of peaches grown east of the Rocky Mountains are brown rot, scab, and bacterial spot. These three widely distributed diseases frequently cause heavy losses to peach growers, shippers, and consumers. Other fungus and bacterial diseases of peaches in this region include leaf curl, rust, constriction, crown gall, powdery mildew, root rots of various types, and dieback.[9]

Brown Rot

Brown rot, the common rot of peaches, starts frequently at an insect puncture as a tiny, circular, brown spot on green or ripening fruit. It is sometimes referred to as gray mold and ripe rot. The surface area affected enlarges rapidly. The rot penetrates deeply in the flesh of the peach. Although the entire peach becomes rotted, it usually retains its form and remains attached to the tree for some time. It then either falls or, if retained on the tree, gradually shrinks and dries into a hard brown to black mummy. Masses of ash-colored spores are produced on the rotted surface; this gives the peach a brownish-gray appearance (fig. 29). These spores, known as conidia, may be carried by insects, birds, wind, or splashing raindrops—or even by man—to nearby healthy peaches, which they infect.

FIGURE 29.—Peaches covered with spores of the brown rot fungus. The infection spreads to the twig from the blighted blossom still attached to it, and to the fruit from the twig.

[8] This section was prepared by H. L. Keil, Crops Research Division.

[9] The organisms causing diseases mentioned are as follows: Brown rot, *Monilinia fructicola* (Wint.) Honey; scab, *Cadosporium carpophilum* Thuem.; bacterial spot *Xanthomonas pruni* (E.F. Sm.) Dows.; leaf curl, *Taphrina deformans* (Berk.) Tul. rust, *Tranzschelia discolor* (Fekl.) Tranz. & Litv.; constriction *Fusicoecum amygdali* Del.; crown gall, *Agrobacterium tumefaciens* (E.F. Sm. & Towns.) Conn.; powdery mildew, *Podosphaera oxyacanthae* (DC.) DBy, and *Sphaerotheca pannosa* Wallr. ex Lev; root rots, *Armillaria mellea* Vahl ex Fr. and allied fungi. *Falsa leucostoma* Pers. ex. Fr., *Polyporus palustris* Berk. & Curt. and *Stereum complicatum* (Fr.) Fr. and other fungi are commonly associated with dieback.

If peach mummies are allowed to remain on the tree, the fungus may grow into the twigs and cause cankers, which may girdle and kill the twigs. In the South, mummies that remain on the trees rarely carry the fungus through the winter. In the North, however, mummies left on the trees over winter often produce numerous fungus spores the following spring (fig. 30).

FIGURE 30.—Peach mummies producing spores (conidia) of the brown rot fungus.

FIGURE 31.—Goblet-shaped fruiting bodies (apothecia) developing from partly buried peach mummy.

These spores may be carried to peach blossoms and may infect them. This produces the phase of the disease known as blossom blight. Mummies clinging to the tree should be removed and destroyed in the fall or winter. If mummies are allowed to accumulate under the trees and become partly buried, they frequently produce goblet-shaped fruiting bodies (fig. 31) known as apothecia, which shoot spores of another kind (ascospores) in the air. These spores, like the conidia, may infect blossoms.

Only occasionally does the brown rot fungus destroy enough blossoms in a peach orchard to thin the crop too much. But even a scattering of blighted blossoms through the trees seriously threatens the crop's safety. The fungus may attack any part of the blossom and cause it to turn gray or light brown. The blossom is soon covered with the gray spores of the fungus, if wet weather prevails. From the infected blossom, the fungus may penetrate the twig, kill twig tissues, and produce a canker. Gum oozes from the twig canker and causes the blighted blossom to adhere to the twig (fig. 32). The blighted blossom produces masses of conidia during the current growing season and sometimes even the following season. Thus, it serves as a source of infection to the ripening fruit.

Brown rot may be controlled by removing rotted fruit from the trees and by removing mummies from the ground or by cultivating underneath the tree to prevent the brown rot fungus from fruiting on old mummies left on the ground. The trees should be properly pruned so that they can be sprayed thoroughly. The fruit should be thinned to reduce spread of the disease from infected to healthy peaches. Insects such as the plum curculio and the oriental fruit moth, which puncture fruits and provide entrance for brown rot spores, should be controlled. The fruit should be sprayed or dusted at regular intervals during the season.

FIGURE 32.—Gum oozing from brown rot twig canker.

The best way to control brown rot is by spraying or dusting.

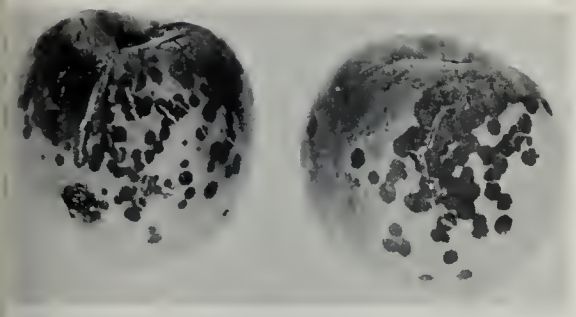
Until a few years ago, sulfur was the most widely recommended chemical for controlling brown rot. Recently, however, sulfur has been partly replaced by organic chemicals such as dichlone and captan. Dichlone (50-percent wettable powder) applied during the early bloom stage at one-fourth and one-half pound per 100 gallons of water effectively reduces blossom blight infection and the resulting twig cankers. Dichlone, however, should not be used following bloom because it may injure the fruit. Captan, although somewhat more expensive than sulfur, has proved less injurious and is more effective in controlling the disease. The materials, concentrations, and number of applications recommended vary among different localities. Growers should consult their State agricultural co leges for local recommendations.

In general, sulfur (6 pounds pe 100 gallons of water) or captan (pounds per 100 gallons of water should be sprayed or dusted five t eight times a season, depending o the variety and on the weather, a the following intervals: (1) Durin pink bud before the blossoms open (2) at blossom time; (3) whe three-fourths of the shucks hav dropped; (4) 10 days after shuc spray; (5) 10 days after the fourt application; (6) 2 weeks after th fifth application; (7) 2 weeks afte the sixth application; and (8) 2 to weeks after the seventh applicatio Sprays or dusts should be applie frequently enough after the fift application to maintain adequa protection against brown ro Dusts are sometimes used just b fore harvest because they do n leave an objectionable deposi which sprays sometimes do. R cently, growers have successfull stored peaches longer by dippin harvested fruit in a water-capta suspension.

Tests have shown that brown r is not so much of a problem if th plum curculio and oriental fru moth are kept under control. (S section on "Peach Insects," p. 67

Scab

Scab, known also as black spot freckles, is a fungus disease peaches in which circular spots on sixteenth to one-eighth inch diameter appear on the fruit usual near the stem end of the expos surface (fig. 33). These spots a faintly green at first but soon b come olive green to black, with we defined margins. When numerou the spots run together and form large, black, scablike area involvi as much as half the surface of t peach. The scabby area frequent splits open; this exposes the fles which may then be infected



IGURE 33.—Scab spots on peaches, showing the cracking that often develops when the spots are numerous.

pores of the brown rot fungus or hizopus rot fungus. Where scab nfections are numerous, the fruit is ikely to be so stunted and mishapen that it cannot be used.

The scab fungus attacks tender reen shoots of the current season, roducing small, brown, oval cankrs that frequently have purplish orders. These cankers are seldom ıore than one-eighth inch long, and ıey extend only slightly below the urface. They rarely cause serious eakening of twigs, but the fungus ı them may remain alive during ıe winter and produce spores the ollowing spring that may infect ıe new crop of fruit. Lesions, hich at first may be pale green and ventually become dark green, may lso be found on the under surfaces f leaves. Only in extremely severe ıses does defoliation occur.

Scab can readily be controlled by pplying sulfur as either a spray or dust. The spray must be aplied 2 weeks after the shucks have ropped from the peaches and again weeks later. Because scab spots ıve not appeared on the fruit, rowers may think their crops are fe from the disease. This is not ways true, because infections ocır early in the season and the funıs grows so slowly that spots are ot visible until 40 to 60 days after fection. When the spots do apear, it is usually too late for spray-g or dusting.

Captan will control scab, but it is ot so effective as sulfur, especially if used at concentrations of less than 2 pounds per 100 gallons of water. For this reason, sulfur should be used when feasible.

Bacterial Spot

Bacterial spot, sometimes called bacteriosis, bacterial shot hole, or just shot hole, results from entrance of a certain kind of bacteria into uninjured tissues of leaves, twigs, and fruit. On leaves, the first sign of the disease is the appearance of small, water-soaked areas that develop into purple or purplish-brown spots (fig. 34), which are generally angular in shape. The individual spots are small at first, but they may run together. Eventually, the affected tissues die and separate from the healthy tissues, producing a characteristic ragged, shot-hole appearance—hence the name "shot hole." When many leaves are affected, especially on weak trees, premature leaf fall often results. The disease is first visible on the fruit as tiny, watery-looking, slightly sunken spots. As the peach grows, cracks and fissures of various sizes develop and mar the appearance of the fruit (fig. 34, *C*). The cracking around the spots of dead tissue makes the fruit unmarketable and frequently permits the entrance of brown rot or other fruit rot fungi.

Cankers are formed on the twigs at various times during the growing season. Some develop on green shoots late in summer ("summer cankers"), usually after foliage infection has become established. Some develop on young, succulent twigs in the spring ("spring cankers"), about the time the first leaves appear. Bacteria responsible for initial infection in the spring are believed to originate from spring rather than summer cankers.

Bacterial spot is present in all States east of the Rocky Mountains where peaches and plums are grown. It causes serious annual losses, chiefly where soils are light and low

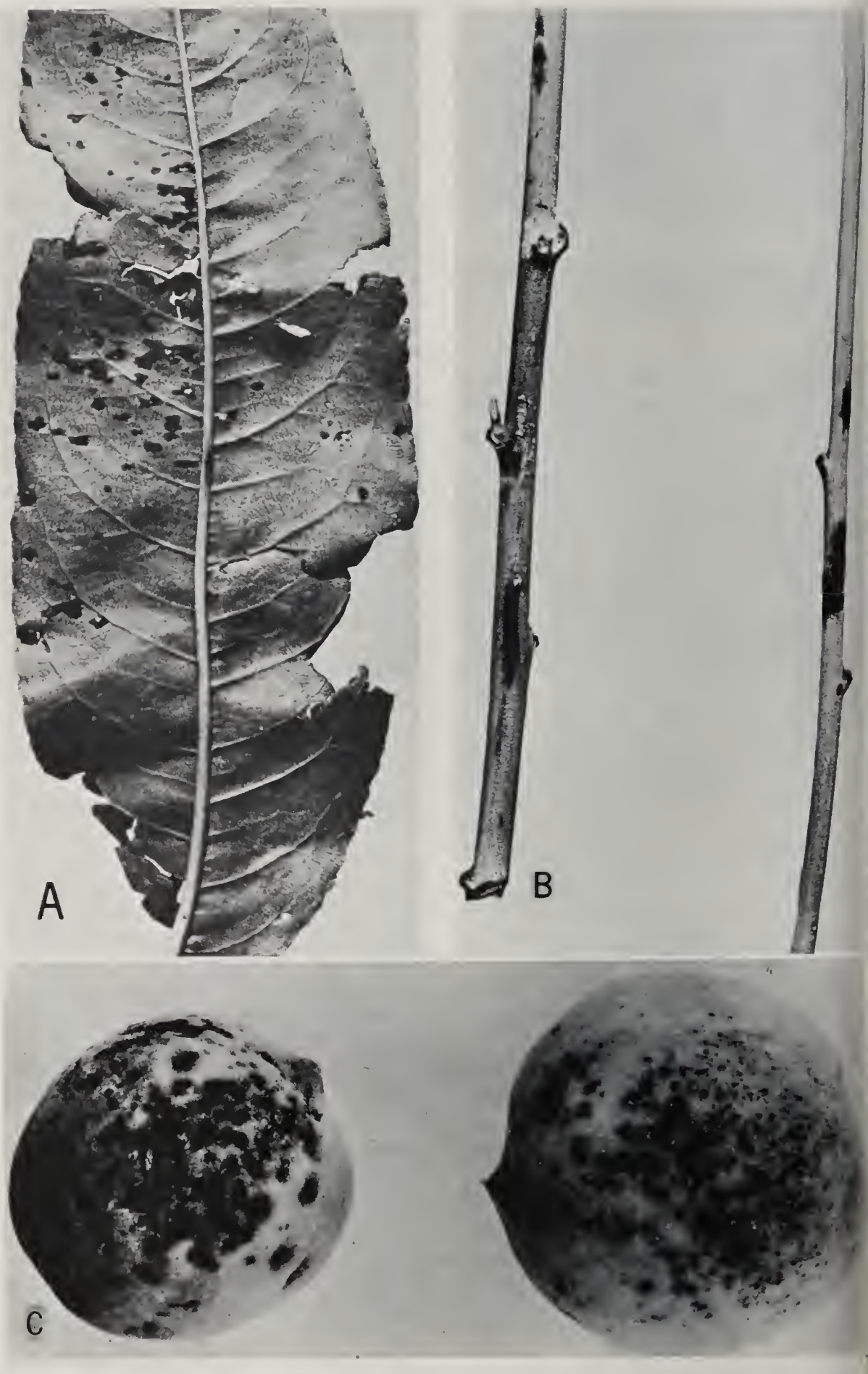


FIGURE 34.—Symptoms of bacterial spot (*A*) on peach leaf, (*B*) on young peach shoots and (C) on mature J. H. Hale peaches.

n fertility. Although as much as 5 percent of the fruit of susceptible varieties may be discarded because of bacterial spot, the greatest loss is due to devitalization of the tree resulting from defoliation. Vigorous trees are less susceptible to the disease than are neglected trees. Proper pruning, cultivating, fertilizing, and other good orchard-management practices are recommended as control measures. But these alone will not control severe bacterial spot infection, especially where soil improvement is difficult. Removing sources of overwintering infections has not as yet been successful.

Bacterial spot has been held in check in some areas by a series of spray applications at 5- to 7-day intervals, starting at petal fall. However, when the disease is severe in other areas, the best materials available have been only about 50 percent effective. More effective materials than those now used are needed.

Many sprays for controlling bacterial spot have been tested over the past 30 years, but none can be considered successful. The most satisfactory combination used today is the zinc-lime spray. The formula recommended is:

Zinc sulfate (monohydrate)	5 pounds.
Hydrated lime	8 pounds.
Water	100 gallons.

A monohydrate zinc sulfate ($ZnSO_4.H_2O$) containing 36 percent zinc can be obtained through wholesalers and distributors who handle spray materials. This material should be stored in a dry place and kept well covered so that it cannot absorb moisture from the air and become lumpy. The hydrated lime should be fresh and of high quality. The grade known in the trade as chemical or spray is especially recommended.

The spray should be prepared as follows: Fill the tank three-fourths full of water. Start the engine and slowly sift the zinc sulfate into the water while the agitator is moving. If the zinc sulfate is not caked, it will dissolve in less than 5 minutes. After the zinc sulfate has dissolved, slowly add the hydrated lime and continue agitating while the tank fills with water. If other fungicides and insecticides are used in combination with zinc sulfate, they should be added at this time. Captan should not be used with strongly alkaline materials, such as hydrated lime.

The zinc-lime spray will not control scab and brown rot. Sulfur sprays, which are commonly used on peaches to control bacterial spot, may safely be applied to peach trees in mixture with the zinc-lime spray.

To reduce bacterial spot, some investigators have suggested the use of Bordeaux mixture spray (copper sulfate plus hydrated lime in water) applied either in the fall when the leaves are ready to drop or in the spring before the buds open. Because of its tendency to burn peaches, copper should never be applied during the growing season. If you wish to try Bordeaux mixture, do so only on recommendation of your county agent or State agricultural extension scientists.

Leaf Curl

Leaf curl, often referred to as "curl," "curl leaf," or "leaf blister," is an economically important disease occurring in all peach-growing regions east of the Rocky Mountains. It is due to a fungus that causes the early appearing peach leaves to acquire a red to purplish tint, which makes them conspicuous. These leaves become thickened, blistered, and distorted; turn reddish yellow or yellowish gray; and later turn brown and drop. The actual time of leaf fall depends on the prevailing weather conditions. Dry, hot weather usually hastens

leaf fall. The spores of the fungus overwinter on the twigs and buds of the peach tree, germinate, and infect the young leaves as they begin to develop in the spring.

If only a small percentage of the leaves are affected, the fruit set will not be materially reduced and the trees will not be seriously injured. But if the number of affected leaves is large enough to cause heavy defoliation at or near blooming time, the disease may prevent fruit set and devitalize the tree so that it becomes subject to winter injury and attacks by other disease-producing organisms.

Peach leaf curl can be controlled by a single application of lime-sulfur solution, Bordeaux mixture, ferbam, or dichlone made in the fall after the trees shed their leaves; during the winter when the temperature is above freezing; or in the spring before the buds begin to swell. If application is delayed until after the leaves start to grow, the disease will not be successfully controlled and some materials applied at the suggested concentrations may seriously injure the trees.

A lime-sulfur solution usually gives satisfactory control when used at the rate of 4 to 6 gallons per 100 gallons of water. However, when leaf curl is severe, somewhat higher rates may be required. A 6–6–100 Bordeaux mixture (6 pounds of copper sulfate plus 6 pounds of hydrated lime in 100 gallons of water), ferbam at the rate of 2 pounds per 100 gallons, or dichlone (50 percent wettable powder) at the rate of 1 pound per 100 gallons of water will also give satisfactory control of peach leaf curl if applied according to directions. All buds on the tree are subject to infection and must, for complete protection, be thoroughly covered with the spray.

Bordeaux mixture may be used in combination with an oil emulsion in the dormant application to control certain insects. The oil should b added after the Bordeaux mixtur is placed in the spray tank.

Rust

Rust is a disease that appears to ward the end of the growing seasor It usually affects the peach leaves but sometimes, under certain climat ic conditions, it appears on twig bark, and fruit. This disease i found most commonly in th warmer sections of the stone frui areas. Numerous pale, yellowis spots that later become bright yel low are evident on the leaf. Di rectly underneath these spots on th lower leaf surface, powdery, cin namon-brown spore masses develo In some seasons, rust infections be come so numerous that they caus premature leaf fall, which weaken the tree. At present, no measure for controlling this disease are prac ticed east of the Rocky Mountain

Constriction

Constriction, sometimes referre to as Fusicoccum canker or peac canker, is a fungus disease that ha become economically important th past two decades in the North A lantic and Middle Atlantic State This disease affects twigs, blossom leaves, and fruit. Dark-brown ca kers, which later become grayis tan, appear at the nodes of the cu rent season's twigs. These canke often girdle the twig, make it wil and eventually kill the affecte branch. Among the varieties s verely affected by the disease a Golden Jubilee, Raritan Rose, Ca dinal, Jerseyland, Triogem, J. H Hale, and Redhaven. Recent stu ies have been made in New Jers on control of late season infectio by postharvest applications of ma nesium arsenate and a certain o ganic mercury compound. Furth tests are necessary, however, befo these materials can be recommend for use by peach growers.

Crown Gall

Crown gall is a bacterial disease haracterized by formation of swell-ıgs or galls on the trunks (usually t the crown) and roots of the trees. 'his disease, although prevalent nd severe in some sections of the outhern States, may be found in ll peach-growing areas east of the ocky Mountains. In many cases, ıe disease has been traced back to ıe planting of infected nursery rees. Nursery trees showing crown all should not be planted. They ill not grow well or mature, and acteria are likely to spread to other rees. Removing the galls does not ree the tree of infection, and little ın be done to control the disease nce it becomes established in an rchard. Considerable research is eing done to find a control for the isease in the nursery; but no prac-ical, satisfactory control has yet een developed.

Powdery Mildew

Powdery mildew, a fungus dis-ıse, was seldom a serious problem eastern commercial peach or-ıards until use of organic chemical rays replaced use of sulfur sprays. hen sulfur is used, powdery mil-ew occurs infrequently and is of no onomic importance. However, out 2 years after the organic com-unds are used, powdery mildew ay often become prevalent and use serious damage. The powdery ildew fungus attacks leaves, young ıoots, and fruit. The leaves may spotted with white to gray ıtches or may be entirely covered a white, powdery layer of the ıngus. The fungus may extend er the entire terminal portion of e growing shoot and may some-mes kill it. Small, white round ots first appear on the fruit. hese spots may increase in size ıtil a large portion or the whole rface of the fruit is involved. ruits so attacked may turn a dull reddish to pinkish color, and may later turn brown. Where powdery mildew becomes serious, sulfur spray or organic compound sprays that include a small amount of sulfur should be used.

Fungus Root Rots

Root rots due to several different fungi may, at times, cause the death of peach trees. The first evidence of root rot may be the appearance of small, yellowish leaves that cover the entire tree or that are confined to one or two branches. The entire tree or the affected branches may die by the end of the summer; or they may survive the winter and die the following year. Once a tree is affected, there is little hope of saving it. Research now being conducted with certain soil fumigants may help solve this problem. Growers finding an appreciable number of trees affected with root rot should consult their State agricultural extension service.

Dieback

"Dieback" is a general name given to a number of conditions that cause the death of peach twigs and branches. Dieback may be caused by various types of fungi and also by some bacterial organisms. These organisms frequently infect the buds or wounds and produce cankers that usually enlarge slowly, sometimes girdling the affected limb or twig. When this occurs during the growing season, the leaves take on a yellowish color and then suddenly wilt and die. Sometimes a gumlike substance is produced on the surface of the canker. In many cases, infection has been associated with spray injury, frost damage, and improperly healed pruning wounds. Insofar as possible, practices should be followed that produce the maximum quantity of marketable fruit with the least damage to the tree.

DISEASES CAUSED BY VIRUSES [10]

Virus diseases were first associated with peach culture in the 19th century. Stories of the devastation and losses resulting from epidemics of peach yellows in Northeastern United States during the 1800's serve as reminders that virus diseases can be serious if they are left uncontrolled. Little peach, another virus disease, which is thought to be caused by a strain of the yellows virus, became damaging in the same geographic area as did yellows in the late 1800's, and now causes more losses than do yellows. In Southeastern United States, peach rosette and phony peach disease, both caused by viruses, have been common since the early 1900's and cause serious crop losses. Within the past 30 years, the following additional virus diseases affecting peaches have appeared in Northeastern United States: Red suture, X-disease, rosette mosaic, necrotic leaf spot, ring spot, and line pattern. Peach mosaic and asteroid spot are virus diseases that occur in Southwestern United States as far east as eastern Texas, southern Oklahoma, and western Arkansas.

For the purpose of this discussion, a virus may be considered as an extremely small organism, too small to be seen through the ordinary compound microscope, which lives and multiplies as a parasite in living tissue. Virus diseases of plants are commonly spread in one of several ways—through juice, by infected propagation material, and occasionally through seeds from infected plants. In nature, they are most commonly spread by insects and mites. These insects suck juice from infected plants and lose some of it while feeding on healthy plants, thereby infecting them. None of the viruses affecting peach trees is known to have been transmitted mechanically from peach to peach with infected juice. Onl one, ring spot, has been found tran missible through seeds. Ring spo passes through some of the seeds o mazzard and mahaleb cherries an occasionally through peach seeds.

It is highly improbable that an of these viruses can be spread b cultivation procedures, such a pruning, spraying, thinning, or til age. They can be spread into ne areas by use of infected nurser stock. Within orchards they can b spread by insects and through use o infected propagation materia Peach yellow bud mosaic, known t occur only in California, and peac rosette mosaic, which occurs i Michigan, in New York, and poss bly in other Eastern States, hav been retained in the soil by nem tode vectors where diseased trees ar removed. Thus, these diseas could be spread by movement of in fested soil.

Peach Yellows

The symptoms of peach yellow are premature ripening of fruit; in ward rolling, drooping leaves, pa green to yellow in color; and de velopment of small, clustered shoo with yellow leaves along the trun and main branches of the tree (fig 35 and 36). Fruit on affected tre ripens from a few days to 3 week earlier than normal, lacks swee ness, and is bitter. The peel on a fected fruit is commonly spotte with red and purple, and on no mally red varieties it may be soli purple. Red streaks of differe lengths extend from the pit towar the peel, and in red varieties th tissue around the pit is deep red.

On young trees and vigorou older trees affected with peach ye lows, buds formed in the summe do not remain dormant but put ou small, yellowish leaves the sam

[10] This section was prepared by L. C. Cochran Crops Research Division.

GURE 35.—The small, willowy growth from main limbs of this tree is a symptom of peach yellows. This growth is known as wire shoots. (Courtesy of Illinois Natural History Survey.)

ason. In advanced cases, the ends f twigs and branches die; and clus- rs of small shoots bearing small, ıle-green to yellow leaves grow om the trunk and main branches. hese are known as wire shoots. ome varieties produce more wire ıoots than others. Affected trees sually die in 2 to 6 years.

Plum trees, both cultivated and wild, have been found to carry the yellows virus; but most plum species are not injured by it and do not show any easily recognized symptoms. The disease is spread by the plum leafhopper (*Macropsis trimaculata*), which prefers to feed on plums and migrates from them to

FIGURE 36.—Closeup view of willowy growth arising from a main limb of a peach tree affect with yellows. Note slenderness of twigs; light color, small size, and abundance of leav and dark spots on leaves. An almost normal water sprout is seen at the base of the lin at the right. (Courtesy of Illinois Natural History Survey.)

peaches. In localities where the disease has become widespread, peaches should not be grown within 1 mile of plums.

Yellows-affected trees should be removed from the orchard as soon as the disease is recognized. If a infected tree is left standing in a orchard, the disease spreads rapi ly to neighboring trees. Son States have laws prohibiting sa of yellows-affected fruit and r

uiring that yellows-affected trees e destroyed. Care should be taken o obtain peach budwood from nown yellows-free sources and to row nursery stock apart from any atural hosts of the yellows virus. 'lum trees considered as a source f material for budding or as root-ocks should be checked for yel-ows before they are used. The yel-ows virus can be killed in peach udwood or in nursery trees with eat, but there is no known method f curing infected orchard trees.

Little Peach

Some symptoms of the little peach isease are enough like those of yel-ows to suggest that little peach is used by a strain of the yellows vi-us. Trees affected with little each, like those with yellows, ave a droopy appearance. In late ages of the disease, the leaves turn ale green to yellowish. Little each is transmitted by the same sect as is yellows. The little each virus is killed by heat at the me temperature that inactivates e yellows virus. Little peach dif-rs from yellows in that fruit on ffected trees fails to ripen, or rip-s late instead of prematurely, d there is less yellowing of foli-ge in the early stages of the disease. rees affected with little peach ap-ear stunted and compact or shy, because there are more aves on the short spurs along e main branches. They do not roduce the slender yellow shoots wire shoots) on the trunk and ain branches that are characteris-c of yellows-affected trees. Leaves n trees in advanced stages of lit-e peach may be curled by recurv-g of the midrib toward the vig, but the halves of the leaves re not as closely folded as they are ith yellows. Fruit is usually nall and has a poor flavor. It oes not have the red color on the eel or in the flesh that is charac-ristic of yellows.

Little peach, like yellows, affects different species and varieties of plums. Some plums show a few symptoms, but some do not.

The control for little peach is the same as for yellows.

Red Suture

Red suture, also, belongs to the yellows group. It has occurred in Michigan, Ohio, and Maryland.

The leaf and tree symptoms of red suture are more nearly like those of little peach than like those of yellows. Leaves on affected trees are recurved, terminal growth is shorter than normal, and an abnormal number of short shoots bearing clusters of leaves arise along the main branches. In advanced cases of red suture, there is some twisting of leaves. Most leaves are lighter than normal in color, and the centers of trees appear open. As with yellows, the fruits on affected trees ripen several days early, the suture ripening first. Frequently, the suture is unevenly swollen. On red fruits, the tops of the ridges and bumps have dark red or purple blotches. The flesh of the early ripening portion is usually soft and watery. The affected fruits are usually low in sweetness and insipid in flavor.

Little is known of the host range of red suture. Insufficient tests have been made to determine whether the leafhopper that spreads peach yellows can spread red suture.

The control for red suture is the same as for yellows, but is less efficient because it is harder to recognize diseased trees, especially in the early stages. Trees may be diseased for a year or longer before they develop recognizable symptoms. During that time they serve as a reservoir from which the disease can be spread.

In the infected area, red suture is becoming more serious.

X-Disease

The X-disease was named for *x*, the symbol of an unknown quantity, because of its peculiar symptoms. Diseased peach trees appear normal until midsummer (the date varies with locality). Then, within a few days, leaves on affected twigs, starting near the base of the current season's shoots, become progressively pale, commonly roll upward, become brittle, and develop irregular yellow and red spots. Some of these spots shrink and fall out. The number of leaves affected and the size of spots on individual leaves increase rapidly, causing affected shoots to become highly colored. Leaves on affected twigs are usually shed progressively from the base to the tip. Tip leaves seldom become affected, and they remain on the tree. During hot weather, leaves often drop before the spots are well formed. Fruits on affected twigs usually shrivel and fall soon after leaf symptoms develop. Fruits on twigs where leaf symptoms develop late in the season may remain on the trees. However, they ripen prematurely and are bitter, and their seeds fail to develop.

Diseased twigs or branches, even though they shed their leaves, do not always die. If they survive, they leaf out normally the following spring; then the sequence of symptoms is repeated. The disease usually begins on one or several twigs and spreads irregularly through the tree. If often takes several years to affect most of the tree. Unlike some of the other viruses affecting peaches, the virus causing X-disease seldom becomes distributed through the whole tree. Normal-appearing twigs on diseased trees are free of the virus and produce normal fruit. Affected trees under 3 years of age frequently die; older trees, although they become unproductive, usually do not die as a direct result of X-disease.

Besides peaches, the X-diseas virus infects cultivated cherrie (both sweet and sour) and severa wild plum and cherry species. Th most commonly affected wild host i the chokecherry (*Prunus virgin iana*). This plant is widespread i Northeastern United States and ad jacent areas of Canada and form dense woodland and fence-ro thickets. The disease appears t have spread rapidly in this hos from where it was first seen in Ne England through New York, Ohi and Michigan and into Wisconsi Illinois, and Iowa. Diseased choke cherries prematurely develop vary ing degrees of autumnal yellow an red foliage, beginning as early a June. They usually die in 3 to years.

X-disease is spread by the leaf hopper *Colladonus clitellariu* (Say). This leafhopper lives prin cipally on chokecherries but occa sionally migrates to other nearb plants. If it has fed first on dis eased chokecherries, it can carry th virus to peach and cherry tree Peach nursery plantings should b at least 500 feet from chokecherrie and other wild cherry or plum spe cies. Eradication of chokecherrie within 500 feet of peach orchard will protect the trees from infection Chokecherries can be effectivel eradicated by spraying them with water solution of ammonium sul famate when they are in full leaf The recommended strength is three fourths pound per gallon, and th recommended rate of application i 2 gallons of spray per 100 squar feet. Sodium or calcium chlorat at the same strength is also effectiv Atlacide, a proprietary materia containing chlorates, is less danger ous and is effective if used accordin to the manufacturer's direction Brush killers such as 2,4,5-T i kerosene, or diesel oil at the rate o 10 to 12 pounds per 100 gallons o oil sprayed around the base of th chokecherry in midsummer, has als

been effective. After the sprayer is used, it must be washed thoroughly (five or six times) with a warm, soapy, soda solution in water.

Sodium and calcium chlorates must be handled with care, since they are flammable.

Phony Disease

Phony disease has caused serious losses in Georgia and Alabama. About 2 million phony-affected peach trees have been removed from orchards in Georgia alone since 1930.

Phony disease dwarfs peach trees and causes them to be darker green and more dense in appearance than normal (fig. 37). The dense appearance is due to an abnormal number of lateral twigs with shortened internodes and a closer spacing

FIGURE 37.—(A) Phony-affected Elberta peach tree at Fort Valley, Ga.; (B) normal Elberta tree in the same orchard.

of fewer but flatter leaves on the twigs. The symptoms are progressive. Diseased trees become noticeable in early summer when normal trees outgrow them. By July, diseased trees are easily distinguished from normal trees. Fruit is smaller on diseased trees than on normal ones and becomes smaller each year because of the disease. Phony disease does not kill peach trees, but affected trees are weakened and are more susceptible to winter injury and other orchard troubles. Trees that become diseased when young never reach productive orchard size.

Phony disease affects all peach varieties similarly. It is spread by several species of large leafhoppers commonly known as sharpshooters. The insects prefer to feed directly in the water-conducting tubes in woody stems. Phony spreads rapidly in some areas and increases in rate in proportion to the age of the trees and the number of diseased trees present. The wild chicasaw plum *Prunus angustifolia* Marsh., which occurs in thickets all through Southern United States, has been found naturally infected near phony-affected peach orchards in Georgia.

Phony-affected peach trees should be destroyed promptly. Surveys have shown that the disease spreads less rapidly among the remaining trees when diseased trees have been removed. In infected areas, wild plums should be eradicated from the vicinity of peach orchards. Quarantines covering the infected area prohibit growing nursery stock within 1 mile of diseased trees.

Peach Rosette

Peach rosette is another virus disease affecting peaches in Southeastern United States. It kills rapidly and has caused severe losses in areas where diseased trees were left standing.

Symptoms of peach rosette generally appear in spring or earl summer. The first formed leave turn yellow, and shoots fail to elon gate. Leaves formed later are sma and, because of shortened stem grow into tight rosettes (fig. 38) The older leaves turn yellow an drop first. Trees affected through out usually die before the end of th growing season. Trees partly af fected may live into the second yea but die by the end of that seasor The disease usually occurs in clos colonies and may spread rapidly The chickasaw plum occasionall becomes naturally infected an serves as a virus reservoir fro which the disease spreads to peac trees. Symptoms on it are simila to those on peaches.

Peach rosette can be effectivel controlled by prompt removal o diseased trees in and near the or chard.

Peach Mosaic

Peach mosaic occurs in South western United States as far eas as eastern Texas, in southern Okla homa, in western Arkansas, an in Mexico. It has caused seriou losses both directly by crop reduc tion and, indirectly, by necessitat ing removal of diseased trees.

As the name implies, the mos common and noticeable symptom o peach mosaic disease is the mottle pattern of yellow and green in th leaves. All peach varieties are sus ceptible to infection, but some ar more seriously damaged tha others. Varieties such as J. H. Hal (or its derivatives), Elberta, Ri Oso Gem, and Fay Elberta are se verely injured. But most clingston varieties endure the most sever forms of the virus with only mod erate damage. Newly infected tree of the J. H. Hale variety are re tarded in the spring and develo small, narrow, deformed leave with various irregular, mottled pat terns (fig. 39). As the seaso progresses, the mottling become

GURE 38.—Orchard tree affected with peach rosette and showing typically rosetted foliage. Such a tree usually dies before the beginning of the next season.

ss distinct, but the trees are warfed and the fruit is bumpy id misshapen. Symptoms vary be- use of the different forms of the rus, some of which are more dam- ging than others. Damage is most vere in cool climates.

Peach mosaic virus is common in rtain wild stone fruits, including e chickasaw plum, wildgoose um (*Prunus munsoniana* Wight Hedr.), and American plum (P. *nericana* Marsh.), as well as in rtain cultivated stone fruits. ome of these hosts act as symptom- ss carriers. The rate of spread is ore rapid in some areas than in others. The natural vector of peach mosaic is a microscopic eriophyid mite, *Eriophyes insidiosus* Kiefer and Wilson, which lives exclusively within retarded buds and which is removed by wind to healthy trees as the buds open.

In areas where very susceptible varieties are grown, losses from peach mosaic can be reduced to less than 1 percent per year by removing diseased trees and excluding tolerant varieties in which symptoms are absent and diagnosis is difficult. In areas where the disease spreads rapidly, where wild hosts are prevalent, or where the cost of removing

FIGURE 39.—Leaves of J. H. Hale peach affected with peach mosaic. The symptoms var from marginal bands in the first leaf at the left to shot hole and veinlet clearing in the leaf c the extreme right.

diseased trees is uneconomical, tolerant varieties can be grown. Since orchards of Elberta and J. H. Hale and other nontolerant varieties make up a large percentage of the freestone acreage in the United States, strong safeguards should be maintained to prevent spread of the peach mosaic disease to noninfected areas. Infected areas are now under quarantine. The sale of peach nursery stock grown within 1 mile of infected trees or of budwood taken from trees within 1 mile of infected trees is prohibited.

Rosette Mosaic, Ring Spot, Necrotic Leaf Spot, Line Pattern, and Asteroid Spot

Several virus diseases affecting peaches in Eastern United States cause only minor crop losses. The most serious of these is rosette mosaic, which occurs principally in Michigan and New York. This disease causes mottling, dwarfing, and rosetting of the foliage, and a corre sponding reduction of tree vigo The causal virus sometimes remain in the soil and can infect a new tre set where a diseased tree was re moved.

The ring spot virus retards sprin growth and causes light-colored an necrotic ring patterns on leave Sometimes ring spot kills and split peach tree bark. Symptoms of rin spot are usually present only durin the first growing season after infec tion. Infected trees appear to re cover, but they retain the viru without visible symptoms in suc ceeding years. In the nursery, in fected buds grafted on health peach seedlings fail to grow. Th virus exists more commonly i plums and cherries than in peache

Necrotic leaf spot differs fro ring spot in that it produces n symptoms in the spring but pr duces dead spots on leaves each yea in midsummer.

Although line pattern is prima ily a plum disease, peaches ha

een infected with it through bud-
ing; and obscure, mottled leaf pat-
rns have resulted.

Asteroid spot in peaches is common in Texas and the Western States. It produces small, star-shaped spots of varying size scattered over the leaves.

PEACH INSECTS [11]

The common insect pests of eaches grown east of the Rocky Iountains are the plum curculio, he peach tree borer, the lesser peach ee borer, the San Jose scale, the riental fruit moth, and a group of icking bugs, including among oth-s the tarnished plant bug and cer-in species of stinkbugs.[12]

Plum Curculio

The plum curculio is a small, umpbacked beetle with a brownish iout, which hibernates in trash in near the orchard. Early in the ring, the curculios move into the ees. If they come from outside e orchard, they appear first on ees in the outer rows and later ove to other parts of the orchard. hey lay eggs in small peaches soon ter the fruits form. The larvae, grubs, feed within the fruit for weeks or more (fig. 40). The ma-re grubs leave the fruit and go to the ground, where they com-ete their development and emerge adult beetles. In the South, a cond generation infests midseason rieties such as Elberta.

Because the development of the rculio varies according to seasonal d local conditions, the control pro-ams vary with the season and lo-lity. Usually, an insecticide is plied three or four times during e month following petal fall. here two generations occur in one season, one or two additional spray applications are made, usually during the month before picking time.

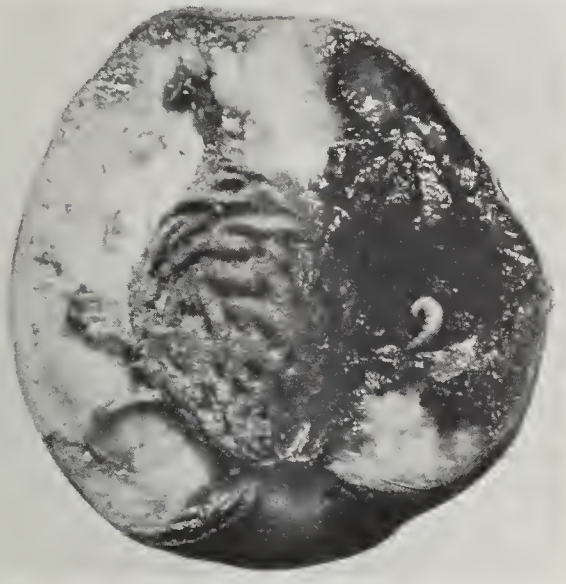


FIGURE 40.—Curculio grub and its injury to ripe peach.

Peach Tree Borer

The peach tree borer is a white worm about 1 inch long that works underneath the bark near the ground line, often injuring the tree seriously or even killing it. At maturity, the larvae change to pupae, then to adults, which are clear-winged moths. In the southern part of the Gulf States, a few moths appear as early as May or June; but heaviest emergence in the South occurs during August and September.

[11] More complete, general information on peach insects and their control is available U.S. Dept. Agr. 1963. Insect pests of the peach east of the Rocky Mountains. gr. Inf. Bul. 272, 32 pp. illus. More detailed information on various peach insects d on new insecticides should be obtained from your local State agricultural college extension service or from your county agricultural agent or farm adviser.

[12] The scientific names of the insects listed are as follows: Plum curculio, *Conotrachelus nenuphar* (Hbst.); peach tree borer, *Sanninoidea exitiosa* (Say); lesser ach tree borer, *Synanthedon pictipes* (Grote & Robinson); San Jose scale, *Aspidiotus perniciosus* Comst.; oriental fruit moth, *Grapholitha molesta* (Busck); tarnished ant bug, *Lygus lineolaris*' (P. de B.); stinkbugs, chiefly *Euschistus* spp.

In the North, most of the moths emerge during July and August. Egg laying begins shortly after moths appear. Most eggs are placed on the tree trunk but some are placed on small branches of the tree or on the soil or weeds nearby. After the eggs hatch, the young larvae move to the lower part of the tree trunk and usually enter it at the soil surface. Usually there is only one generation a year.

Lesser Peach Tree Borer

The lesser peach tree borer is similar to the peach tree borer but mainly attacks the trunk and limbs, particularly in injured areas and in crotches. It passes the winter as a larva in injured areas on the tree. It pupates early in the spring and emerges as a clearwinged moth that lays its eggs along the trunk and limbs of the tree. One generation occurs in the North, and two occur in the South.

San Jose Scale

The San Jose scale is a tiny insect that lives under a very small, inconspicuous, grayish, scalelike covering. Small reddish discolorations are often found at the point of feeding, particularly on new, tender wood. Heavily infested trees have a roughened, grayish appearance. Other signs of infestation are dead twigs and limbs, and a lowering of the vitality of the trees. A heavy, continuing infestation may kill the trees.

All stages of the scale are present most of the year, but scales that are partly grown survive the winter best. They complete their growth in the spring. The insect remains in one place except during the first few hours of its life and during the short time adult males are active. The generations overlap; there are one or two generations a year in the more northern fruit areas and three or more farther south.

Oriental Fruit Moth

The larva of the oriental fruit moth is a pinkish-white worm with a brown head. When fully grown, it is about one-half inch long. Early in the season, the larvae tunnel into new peach shoots (fig. 41), causing them to wilt and dry up. Later, usually near harvest, the larvae bore into the fruit. Infestation of fruit is heaviest in midseason and in the later maturing peach varieties. The insects pass the winter as full-grown larvae, or worms, in cocoons in a protected place on the tree or ground. Moths first appear about the time peach trees are in bloom. The females usually lay their eggs on the leaves. The larvae feed on twigs or in the fruit until they are mature and then spin cocoons in a protected place on the tree or ground. Usually there are four or five generations each year.

Sucking Bugs

The tarnished plant bug and several other species of sucking bugs feed on peach blossoms and on newly formed peaches and cause the fruit to become seriously scarred and distorted (fig. 42). These bugs live and feed chiefly on weeds or field crops in or near the orchard. They suck on peaches for only a short period in the spring. Where it is consistent with good horticultural practice, eliminating weeds and certain cover crops aids considerably in controlling them.

FIGURE 41.—Oriental fruit moth injury to peach twigs.

FIGURE 42.—Peach injury caused by sucking bugs.

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AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

COMPILATION

OF

STATUTES RELATING

TO

Soil Conservation, Marketing Quotas and Allotments, Soil Bank, Commodity Credit Corporation, Price Support, Export and Surplus Removal, Crop Insurance, Sugar Payments and Quotas, Marketing Agreements and Orders, School Lunch, Food Stamp, and Related Statutes

AS OF JANUARY 1, 1965

COMPILED UNDER THE DIRECTION
OF THE GENERAL COUNSEL

AGRICULTURE HANDBOOK NO. 281

For sale by the Superintendent of Documents, U.S. Government Printing Office
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Prefatory Note

This is a compilation of legislation administered by the Agricultural Stabilization and Conservation Service and related legislation. Certain provisions of law which were applicable to prior years or crops, but which have not been repealed by the Congress, have been omitted from this compilation. These may be found in prior compilations. The language of the legislation appearing in this compilation is as it appears in the U.S. Statutes at Large, but, for the convenience of the reader, citations are made at the end of sections and subsections to the U.S. Code, 1958 edition and supplements thereto. The subject headings used herein are generally those as enacted; some of them, however, have been changed and other headings have also been added by the editors of this compilation for explanatory purposes.

The statutes contained in this compilation are subject to the provisions of Reorganization Plan No. 2 of 1953 (18 F.R. 3219, 67 Stat. 633, 5 U.S.C. 133z–15, note), prepared by the President and transmitted to the Senate and House of Representatives on March 25, 1953, pursuant to the provisions of the Reorganization Act of 1949 (5 U.S.C. 133z to 133z–15). The plan transfers to the Secretary of Agriculture all functions not then vested in him of all other officers and of all agencies and employees of the Department of Agriculture, except functions vested by the Administrative Procedure Act in hearing examiners employed by the Department and functions of the corporations of the Department, the Boards of Directors and officers of such corporations, the Advisory Board of the Commodity Credit Corporation, and the Farm Credit Administration.

NOTE.—This Handbook is a revision of and supersedes Agriculture Handbook No. 242, dated January 1, 1963.

CONTENTS

PART I. SOIL CONSERVATION AND DOMESTIC ALLOTMENT ACT, AS AMENDED

Page

Sec. 1. Policy of Congress 1
Sec. 2. Lands on which preventive measures may be taken 1
Sec. 3. Benefits for non-Government controlled lands 2
Sec. 4. Cooperation of governmental agencies, personnel, and supplies 2
Sec. 5. Establishment of "Soil Conservation Service" 2
Sec. 6. Appropriation authorized 3
Department of Agriculture Organic Act of 1944. Sec. 302(b). Sale of supplies by the Soil Conservation Service to other Government activities 3
Sec. 7. Agricultural conservation policy 3
Sec. 8. Payments and grants of aid 4
Department of Agriculture Organic Act of 1956. Sec. 6(b). Payments conditional upon soil-building and soil- and water-conserving practices 6
Public Law 85–278. Two county committees established in one county in certain States 6
Naval stores conservation program 11
Public Law 85–25. Deferred grazing program 11
Sec 9. Surveys, investigations, and reports 12
Sec. 10. "Agricultural commodity" defined 12
Sec. 11. Availability of funds 12
Sec. 12. Expansion of markets and crop insurance advance 13
Sec 13. Execution of powers of Secretary by Production and Marketing Administration 13
Sec. 14. Finality of payments 14
Sec. 15. Appropriation authorization and allocating of funds 14
Sec. 16(a). Limitation on obligations incurred 15
Sec. 16(b). Great Plains Conservation Program 15
Sec. 16(c). Feed grain program for 1961 17
Sec. 16(d). Feed grain program for 1962 17
Sec. 16(e). Land use adjustment program 17
Sec. 16(f). Disbursements to producers 19
Sec. 16(g). Feed grain program for 1963 19
Sec. 16(h). Feed grain program for 1964 and 1965 19
Sec. 16A. Payment limitation as to wetlands in States of North Dakota, South Dakota and Minnesota 22
Sec. 17. Scope of Act and definition of "State" 23

PART II. AGRICULTURAL ADJUSTMENT ACT OF 1938, AS AMENDED

Sec. 1. Short title 27
Sec. 2. Declaration of policy 27

Title II. Adjustments in Freight Rates, New Uses and Markets, and Disposition of Surpluses

Sec. 201. Adjustments in freight rates for farm products 27
Sec. 202. New uses and new markets for farm commodities (regional research laboratories) 28

PART II. AGRICULTURAL ADJUSTMENT ACT OF 1938, AS AMENDED—Continued

TITLE III. LOANS, PARITY PAYMENTS, CONSUMER SAFEGUARDS, MARKETING QUOTAS, AND MARKETING CERTIFICATES

SUBTITLE A. DEFINITIONS, PARITY PAYMENTS, AND CONSUMER SAFEGUARDS

	Page
Sec. 301. Definitions	29
Agricultural Act of 1948. Sec. 302(f). Parity and parity prices	32
Sec. 303. Parity payments	39
Sec. 304. Consumer safeguards	39

SUBTITLE B. MARKETING QUOTAS

PART I. MARKETING QUOTAS—TOBACCO

Sec. 311. Legislative findings	39
Sec. 312. National marketing quota and referendum	40
Sec. 313. Apportionment of marketing quota and acreage allotments	41
Act of July 12, 1952. Minimum farm acreage allotment, for 1956 and subsequent crops of Burley tobacco	41
Sec. 314. Penalties	45
Sec. 315. Farm acreage allotments for Virginia fire- and sun-cured tobacco	46
Sec. 316. Lease and transfer of tobacco allotments	48

PART II. ACREAGE ALLOTMENT—CORN

Sec. 321. Legislative findings	49
Sec. 326. Adjustment of farm marketing quotas	51
Sec. 327. Proclamations of commercial corn-producing area	51
Sec 328. Acreage allotment	52
Sec. 329. Apportionment of acreage allotment	52
Sec. 330. Nonestablishment of acreage allotments	52

PART III. MARKETING QUOTAS—WHEAT

Sec. 331. Legislative findings	52
Sec. 332. Proclamations of supplies and allotments	54
Pub. L. 88-297	55
Sec. 333. National acreage allotment	55
Sec. 334. Apportionment of national acreage allotment	56
Sec. 334a. Commercial area	60
Sec. 335. Small farm exemptions	61
Pub. L. 74, 77th Cong., Marketing quotas and farm marketing excess	61
Sec. 336. Referendum	64
Sec. 337. Adjustment and suspension of quotas	65
Sec. 338. Transfer of quotas	65
Sec. 339. Land use	65

PART IV. MARKETING QUOTAS—COTTON

Sec. 341. Legislative findings	68
Sec. 342. National marketing quota	69
Sec. 343. Referendum	70
Sec. 344. National, State, county, and farm acreage allotments	70
Sec. 345. Farm marketing quotas and farm marketing excess	76
Sec. 346. Penalties	77
Sec. 347. Extra long-staple cotton	77
Sec. 348. Cotton equalization payments	78
Sec. 349. Export market acreage	79
Sec. 350. Domestic acreage allotments	80

PART II. AGRICULTURAL ADJUSTMENT ACT OF 1938, AS AMENDED—Continued

PART V. MARKETING QUOTAS—RICE

	Page
Sec. 351. Legislative findings	81
Sec. 352. National acreage allotment	82
Sec. 353. Apportionment of national acreage allotment	82
Pub. L. 88–160. Validity of acreage allotment	84
Sec. 354. Proclamation of quotas and conducting referendum	87
Sec. 355. Farm marketing quota and farm marketing excess	87
Sec. 356. Penalties and storage	88

PART VI. MARKETING QUOTAS—PEANUTS

Sec. 357. Legislative findings	89
Sec. 358. Proclamation of national quota, conducting referendum, and establishing acreage allotments	90
Sec. 359. Marketing penalties	93

SUBTITLE C. ADMINISTRATIVE PROVISIONS

PART I. PUBLICATION AND REVIEW OF QUOTAS

Sec. 361. Application of provisions for publication and review of quotas	95
Sec. 362. Publication and notice of quota	95
Sec. 363. Review by review committee	95
Sec. 364. Review committee compensation	95
Sec. 365. Institution of proceedings	95
Sec. 366. Court review	96
Sec. 367. Stay of proceedings and exclusive jurisdiction	96
Sec. 368. Effect of increase on other quotas	97

PART II. ADJUSTMENT OF QUOTAS AND ENFORCEMENT

Sec. 371. General adjustment of quotas	97
Sec. 372. Payment, collection and refund of penalties	97
Sec. 373. Reports and records	98
Sec. 374. Measurement of farms and report of plantings	99
Sec. 375. Regulations	100
Sec. 376. Court jurisdiction	100
Sec. 377. Preservation of unused acreage allotments	101
Sec. 378. Allotment pool for commodities for any land from which farmer is displaced by eminent domain	101

SUBTITLE D. WHEAT MARKETING ALLOCATION

Sec. 379a. Legislative findings	103
Sec. 379b. Wheat marketing allocation	104
Sec. 379c. Marketing certificates	105
Sec. 379d. Marketing restrictions	107
Sec. 379e. Assistance in purchase and sale of marketing certificates	108
Sec. 379f. Conversion factors	108
Sec. 379g. Authority to facilitate transition	108
Sec. 379h. Reports and records	109
Sec. 379i. Penalties	109
Sec. 379j. Regulations	110

SUBTITLE F. MISCELLANEOUS PROVISIONS AND APPROPRIATIONS

PART I. MISCELLANEOUS

Sec. 383. Insurance of cotton and reconcentration of cotton	110
Act of June 16, 1938. Reconcentration of cotton	111
Sec. 385. Finality of farmers' payments and loans	111

PART II. AGRICULTURAL ADJUSTMENT ACT OF 1938, AS AMENDED—Continued

Page
Sec. 386. Exemption from laws prohibiting interest of Members of Congress in contracts ---- 111
Sec. 387. Photographic reproductions and maps ---- 112
Sec. 388. Utilization of local agencies ---- 112
Sec. 389. Personnel ---- 112
Sec. 390. Separability ---- 113

PART II. APPROPRIATIONS AND ADMINISTRATIVE EXPENSES

Sec. 391. Authorization for appropriations and advances for crop insurance ---- 113
Sec. 392. Administrative expenses ---- 114
Sec. 393. Allotment of appropriation ---- 115

PART III. SOIL BANK ACT, AS AMENDED

Sec. 101. Short title ---- 117
Sec. 102. Declaration of policy ---- 117

SUBTITLE A. ACREAGE RESERVE PROGRAM

Sec. 103. Terms and conditions ---- 118
Sec. 104. Extent of participation in program ---- 119
Sec. 105. Compensation of producers ---- 120
Sec. 106. Effect on acreage allotments and quotas ---- 121

SUBTITLE B. CONSERVATION RESERVE PROGRAM

Sec. 107. Terms and conditions ---- 121
Sec. 108. Conservation reserve goal ---- 124
Sec. 109. Authorized period of contracts and expenditures ---- 124
Sec. 110. Termination and modification of contracts ---- 125
Sec. 111. Conservation materials and services ---- 125
Sec. 112. Effect on other programs ---- 126
Sec. 113. Geographical applicability ---- 126

SUBTITLE C. GENERAL PROVISIONS

Sec. 114. Compliance with acreage allotments ---- 126
Sec. 115. Reapportionment prohibited ---- 127
Sec. 116. Certificate of claimant ---- 127
Sec. 117. Utilization of local and State committees ---- 127
Sec. 118. Utilization of other agencies ---- 128
Sec. 119. Utilization of land use capability data ---- 128
Sec. 120. Financing ---- 128
Sec. 121. Finality of determinations ---- 128
Sec. 122. Protection of tenants and sharecroppers ---- 129
Sec. 123. Penalty for grazing or harvesting ---- 129
Sec. 124. Regulations ---- 129
Sec. 125. Production on government lands prohibited ---- 129
Sec. 126. Pooling of conservation reserve land ---- 130
Sec. 127. Compensation for incorrect information furnished under 1956 program ---- 130
Sec. 128. Compensation for incorrect information furnished under the Soil Bank-Act ---- 130

PART IV. PRICE SUPPORT, SALES, AND OTHER DISPOSAL

SUBPART A. LEGAL HISTORY AND CHARTER OF COMMODITY CREDIT CORPORATION

Page

LEGAL HISTORY OF COMMODITY CREDIT CORPORATION -- 133
COMMODITY CREDIT CORPORATION CHARTER ACT ---------- 135
Sec. 1. Short title ---------- 135
Sec. 2. Creation and purposes ---------- 135
Sec. 3. Offices ---------- 135
Sec. 4. General powers ---------- 135
Sec. 5. Specific powers ---------- 138
Sec. 6. Existing statutes applicable to the Corporation ---------- 139
Sec. 7. Capital stock ---------- 139
Sec. 8. Use of funds by Corporation ---------- 139
Sec. 9. Board of directors and advisory board ---------- 140
Sec. 10. Personnel of Corporation ---------- 140
Sec. 11. Cooperation with other Governmental agencies ---------- 140
Sec. 12. Utilization of associations and trade facilities ---------- 141
Sec. 13. Records, annual report ---------- 141
Sec. 14. Interest of Members of Congress ---------- 141
Sec. 15. Crimes and Offenses ---------- 141
Sec. 16. Transfer of assets of Delaware Corporation ---------- 141
Sec. 17. Dissolution of Delaware Corporation ---------- 143
Sec. 18. Effective date of Act ---------- 143
Sec. 19. Release of Innocent Purchasers of Converted Goods ---------- 143

SUBPART B. PRICE SUPPORT

AGRICULTURAL ACT OF 1949, AS AMENDED ---------- 147
Sec. 1. Short title ---------- 147

TITLE I. BASIC AGRICULTURAL COMMODITIES

Sec. 101. Price support for basic agricultural commodities ---------- 147
Sec. 102. Program for 1959 and 1960 (cotton) ---------- 149
Sec. 103. Price support for 1961 and subsequent years (cotton) ---------- 150
Sec. 104. Referendum (corn) ---------- 151
Sec. 105. Price support for 1959 and subsequent years (corn and feed grains) ---------- 151
Sec. 106. Price support for 1960 and subsequent years (tobacco) ---------- 153
Sec. 107. Price support for 1964 and subsequent years (wheat) ---------- 154

TITLE II. DESIGNATED NONBASIC AGRICULTURAL COMMODITIES

Sec. 201. Price support for designated nonbasic agricultural commodities ---------- 155
Sec. 202. Transfer of dairy products to the military and veterans hospitals ---------- 156
Sec. 203. Price support for cottonseed and soybeans ---------- 156

TITLE III. OTHER NONBASIC AGRICULTURAL COMMODITIES

Sec. 301. Price support for other nonbasic agricultural commodities -- 156
Sec. 302. Price support for storable nonbasic agricultural commodities ---------- 157
Sec. 303. Levels of price support for competing agricultural commodities to be considered ---------- 157

PART IV. PRICE SUPPORT, SALES, AND OTHER DISPOSAL—Continued

TITLE IV. MISCELLANEOUS

Page

Sec. 401. Support through CCC, factors to be considered in supporting prices, compliance by producers, date to be used in determining level of price support, and processor programs 157
Sec. 402. Price support at increased level 159
Sec. 403. Adjustments for grades and other factors 159
Sec. 404. Utilization of CCC in section 32 and school lunch programs 159
Sec. 405. Nonrecourse loans 160
Sec. 406. Advance announcement of price support level 160
Sec. 407. Restrictions on sales by Commodity Credit Corporation 160
Sec. 408. Definitions 163
Sec. 412. Determinations by the Secretary 165
Sec. 413. When price support provisions effective 165
Sec. 414. Repeal of section 302 of Agricultural Adjustment Act 165
Sec. 416. Disposition of commodities to prevent waste 165
Sec. 417. Storage structure loans to cooperatives 167
Sec. 420. Price support for cottonseed 168

AGRICULTURAL ACT OF 1954 169

TITLE I. SET ASIDE OF AGRICULTURAL COMMODITIES

TITLE VI. AGRICULTURAL ATTACHÉS

TITLE VII. NATIONAL WOOL ACT OF 1954

Sec. 701. Short title 170
Sec. 702. Policy of Congress 170
Sec. 703. Price support for wool and mohair 170
Sec. 704. Payments as a means of price support 171
Sec. 705. Appropriation to cover payments 171
Sec. 706. Adjustments for grade and other factors and determinations by Secretary 172
Sec. 707. Marketing year 172
Sec. 708. Advertising and sales promotion programs 172
Sec. 709. Amendments to the Agricultural Act of 1949 173

SUBPART C. SALES

Agricultural Act of 1949. Sec. 407. Sales in general 175
Joint Resolution of July 10, 1957. Sale of stockpile cotton 177
Act of July 25, 1962. Sale and disposal of government stocks of cotton 177

SUBPART D. BARTER AND EXCHANGE OF SURPLUS COMMODITIES

Commodity Credit Corporation Charter Act. Sec. 4(h). Exchange of agricultural commodities for strategic materials 179
Agricultural Trade Development and Assistance Act of 1954, as Amended. Sec. 303. Types of goods to be acquired by barter 179
Agricultural Act of 1956. Sec. 206. Transfer of bartered goods to supplemental stockpile 180
Act of August 11, 1939 181

SUBPART E. EXPORT AND SURPLUS REMOVAL

AGRICULTURAL ACT OF 1956 183

TITLE II. SURPLUS DISPOSAL

Sec. 201. Program of orderly liquidation 183
Sec. 202. Extra-long staple cotton 184
Sec. 203. Export sales program for cotton 184

PART IV. PRICE SUPPORT, SALES, AND OTHER DISPOSAL—Continued

AGRICULTURAL ACT OF 1956—Continued Page
Agricultural Act of 1958. Sec. 110. Cotton export program 185
Public Law 88-638. Export sale of extra long staple cotton 185
Act of July 25, 1962. Sale and disposal of government stocks of cotton 186
Sec. 204. Agreements limiting imports 186
Sec. 205. Appropriation to supplement section 32 funds 186
Sec. 206. Transfer of bartered materials to supplemental stockpile 186
Sec. 207. Surplus disposal administrator 187
Sec. 208. Payment of ocean freight 187
Sec. 209. Commission to recommend legislation providing for increased industrial use of agricultural products 187
Sec. 210. Donation to penal and correctional institutions 187
Sec. 211. Federal irrigation, drainage, and flood-control projects 187

INTERNATIONAL WHEAT AGREEMENT ACT OF 1949 189
Sec. 1. Short title 189
Sec. 2. Making wheat and flour available under the International Wheat Agreement 189
Sec. 3. Other action and issuance of rules and regulations 190
Act of August 1, 1953. Sec. 2. References to International Wheat Agreement deemed to include revised agreement 192
Act of August 3, 1956. Sec. 2. References to International Wheat Agreement deemed to include 1956 agreement 192
Joint Resolution of August 11, 1939. Sale to foreign governments 192

AGRICULTURAL TRADE DEVELOPMENT AND ASSISTANCE ACT OF 1954 193
Sec. 1. Short title 193
Sec. 2. Policy of Congress 193

TITLE I. SALES FOR FOREIGN CURRENCY

Sec. 101. Sale of surplus commodities for foreign currencies 194
Sec. 102. Use of Commodity Credit Corporation stocks and funds 195
Sec. 103. Appropriation to reimburse CCC 196
Sec. 104. Use of foreign currencies 197
Sec. 105. Deposit of foreign currencies 202
Sec. 106. Definition of surplus agricultural commodities 203
Sec. 107. Definition of friendly nation 203
Sec. 108. Report to Congress 203
Sec. 109. Expiration date 204

TITLE II. FAMINE RELIEF AND OTHER ASSISTANCE

Sec. 201. Transfer of Commodity Credit Corporation surplus commodities to friendly nations 204
Sec. 202. Transfers on a grant basis 204
Sec. 203. Limitation on value of commodities transferred 204
Sec. 204. Expiration date 205

TITLE III. GENERAL PROVISIONS

Sec. 303. Barter for other commodities 206
Sec. 304. Assisting friendly countries to be independent of trade with the U.S.S.R. 206
Sec. 305. Identification of packages 207
Sec. 307. Domestic donations before foreign currency sales 207
Sec. 308. Donation of animal fats and edible oils and their products 207

TITLE IV. LONG-TERM SUPPLY CONTRACTS

Sec. 401. Purpose of title 208
Sec. 402. President authorized to enter into agreement with friendly nations 208

PART IV. PRICE SUPPORT, SALES, AND OTHER DISPOSAL—Continued

AGRICULTURAL TRADE DEVELOPMENT AND ASSISTANCE ACT OF 1954—Continued

Page

Sec. 403. Payments in dollars 208
Sec. 404. Precautions as not to replace cash sales 208
Sec. 405. Agreement with other countries on proportionate and equitable basis 209
Sec. 406. Application of other provisions 209

SEC. 32 AND RELATED STATUTES:

Sec. 32 of Public Law 320, 74th Cong 211
Act of June 28, 1937. Purchase of commodities for utilization under section 32 212
Agricultural Act of 1949. Sec. 404. Utilization of Commodity Credit Corporation in section 32 and school lunch programs 213
Agricultural Act of 1956. Sec. 205. Appropriation to supplement section 32 funds 213
Act of August 11, 1939. Purchase and distribution of fishery products 213
Act of September 6, 1958. Sec. 9. Donations of surplus commodities abroad 215
Department of the Interior Appropriation Act, 1965. Distribution of food in trust territories of Pacific 215

SUBPART F. DONATIONS

Agricultural Act of 1949. Sec. 416. Disposition of commodities to prevent waste 217
Agricultural Act of 1954. Sec. 204(c). Domestic disposal of dairy products 218
Act of July 1, 1958, as amended. Milk for children 218
Agricultural Act of 1949. Sec. 202. Transfer of dairy products to the military and veterans hospitals 219
Act of September 13, 1960, as amended. Surplus foods for home economic courses 220
Act of August 19, 1958. Donations of processed grain food products 220
Agricultural Act of 1956. Sec. 210. Donations to penal and correctional institutions 221
Agricultural Act of 1958. Sec. 505. Cotton for colleges 221
Act of September 21, 1959. Sec. 201. Enrichment of, and sanitary containers for cornmeal, grits, rice and white flour distribution 221
Act of September 6, 1958. Donations to areas under U.S. jurisdiction; donations of fats and oils 222
Agricultural Trade Development and Assistance Act of 1954 as amended. Sec. 308. Donations of fats and oils 222
Food and Agriculture Act of 1962. Sec. 205. Foreign school feeding programs 223
Agricultural Trade Development and Assistance Act of 1954, as amended. Sec. 305. Donor-identification 223
Mutual Security Act of 1954, as amended. Sec. 402. Domestic distribution of surplus foods available for grant or foreign currency sales 223
Agricultural Trade Development and Assistance Act of 1954, as amended. Sec. 307. Domestic donations before foreign currency sales 224

SUBPART G. FARM DISASTER RELIEF

Act of September 30, 1950. Providing assistance in major disasters 225
Agricultural Act of 1949. Sec. 407. Farm commodity available in case of economic distress or major disasters 226
Act of September 21, 1959. Sale at support price of feed for livestock in emergency area 227
Act of September 7, 1957. Relief to farmers and dealers in connection with claim under emergency feed program 228
Agricultural Act of 1949. Sec. 421. Unauthorized use of feed 228

PART IV. PRICE SUPPORT, SALES, AND OTHER DISPOSAL—Continued

Page

Economic Opportunity Act of 1964. Sec. 331(a). Indemnity payments to dairy farmers 228
Supplemental Appropriation Act, 1965 229
Public law 85–58. Emergency conservation measures 229

SUBPART H. GRAIN FOR WILD FOWL

Act of July 3, 1956 231
Act of August 17, 1961 232

SUBPART I. GENERAL FISCAL STATUTES

Act of March 8, 1938, as amended 233
Pub. L. 87–155. Annual appropriation to reimburse Commodity Credit Corporation 233
Sec. 4. Borrowing power 233
Sec. 5. Taxation 234
Act of July 16, 1943. Sec. 3. Federal Reserve Banks as fiscal agents. 1961 Appropriation Act. Administrative expense limitation 235
Act of July 16, 1943. Sec. 4. Reimbursement by other agencies 235
Department of Agriculture Organic Act of 1944. Sec. 402. Reimbursement of procurement costs 235
Agricultural Adjustment Act of 1938, as amended. Sec. 391(c). Crop insurance premium and conservation materials advances 236
Department of Agriculture Appropriation Act, 1950. Classing or grading without charge for producers obtaining price support 236
Department of Agriculture Appropriation Act, 1952. Classing or grading without charge—reimbursement 236

SUBPART J. MISCELLANEOUS COMMODITY CREDIT CORPORATION STATUTES

Act of June 30, 1949, as amended. Sec. 602. Exemption from Federal Property and Administrative Services Act 237
Internal Revenue Code of 1954. Secs. 77 and 1016. Treatment of Commodity Credit loans for income tax purposes 237
Agricultural Adjustment Act of 1938. Sec. 383. Insurance of cotton and reconcentration of cotton 238
Taft Anti-Inflation Law. Sec. 7. Stimulation of foreign production 238
Other principal statutes having applicability to Commodity Credit Corporation 238

PART V. FEDERAL CROP INSURANCE ACT, AS AMENDED

Sec. 501. Short title 242
Sec. 502. Declaration of purpose 242
Sec. 503. Creation of "Federal Crop Insurance Corporation" 242
Sec. 504. Capital stock 242
Sec. 505. Management of Corporation 242
Sec. 506. General powers 243
Sec. 507. Personnel 244
Sec. 508. Crop insurance 245
Sec. 509. Indemnities exempt from levy 247
Sec. 510. Deposit of funds 247
Sec. 511. Tax exemption 248
Sec. 512. Fiscal agent of Government 248
Sec. 513. Accounting by Corporation 248
Sec. 514. Crimes and offenses 248
Sec. 515. Advisory committee 248
Sec. 516. Appropriations and regulations 249
Sec. 517. Separability 249
Sec. 518. "Agricultural commodity" defined 249
Sec. 519. Right to amend 249
Criminal provisions applicable to Federal Crop Insurance Corporation 249

PART VI. SUGAR ACT OF 1948, AS AMENDED

TITLE I. DEFINITIONS

Page
Sec. 1. Short title ... 255
Sec. 101. Definitions ... 255

TITLE II. QUOTA PROVISIONS

Sec. 201. Annual estimate of consumption in continental United States ... 257
Sec. 202. Proration of quotas ... 258
Sec 203. Consumption estimates and quotas for Hawaii and Puerto Rico ... 261
Sec. 204. Proration of quotas deficits ... 262
Sec. 205. Allotments of quotas or prorations ... 262
Sec. 206. Sugar-containing products ... 265
Sec. 207. Direct consumption sugar quotas ... 265
Sec. 208. Liquid sugar quotas, foreign ... 266
Sec. 209. Prohibited acts ... 267
Sec. 210. Determinations in terms of raw value ... 267
Sec. 211. Exportation of sugar ... 267
Sec. 212. Inapplicability of quota provisions ... 268
Sec. 213. Import fee ... 268

TITLE III. CONDITIONAL PAYMENT PROVISIONS

Sec. 301. Conditions for payments to producers ... 269
Sec. 302. Establishment of proportionate shares for farms ... 270
Sec. 303. Acreage abandonment and crop deficiency payments ... 273
Sec. 304. Computation of payments and persons eligible for payments ... 273
Sec. 305. Use of local committees and other agencies ... 274
Sec. 306. Finality of determinations ... 275
Sec. 307. Areas in which payments may be made ... 275

TITLE IV. GENERAL PROVISIONS

Sec. 401. Personnel and expenditures ... 275
Sec. 402. Authorized annual appropriation ... 275
Sec. 403. Secretary to issue regulations and determinations ... 275
Sec. 404. Jurisdiction of courts to enforce Act ... 276
Sec. 405. Penalties ... 276
Sec. 406. Obtaining of information by Secretary ... 276
Sec. 407. Prohibition against speculation by members of Department ... 277
Sec. 408. Suspension of quotas or payments ... 277
Sec. 409. Surveys and investigations ... 278
Sec. 410. Surveys and investigations, generally ... 278
Sec 411. International Sugar Agreement ... 278
Sec. 412. Termination of Act ... 278
Sec. 413. Effective date of Act ... 279

INTERNAL REVENUE CODE—SUGAR

Sec. 4501. Imposition of tax ... 279
Sec. 4502. Definitions ... 279
Sec. 4503. Exemptions for sugar manufactured for home consumption ... 280
Sec. 6418. Livestock feed, distillation of alcohol, and exportation refunds ... 280
Sec. 6511. Limitations on credit or refund ... 281
Sec 7240. Penalty for officials investing or speculating in sugar ... 281

PART VII. MISCELLANEOUS LAWS

STATUTES RELATING TO IMPORTS:

Agricultural Act of 1956. Sec. 204. Agreements limiting exports ... 284
Sec. 22 of Agricultural Adjustment Act of 1933 (Reenacted by the Agricultural Marketing Act of 1937) ... 284
Public Law 88–482. Import quota on meat and meat products ... 286

PART VII. MISCELLANEOUS LAWS—Continued

Page

MISCELLANEOUS PROVISIONS RELATING TO ACREAGE DIVERSIONS:
Sec. 326 of Food and Agriculture Act of 1962 287
Sec. 327 of Food and Agriculture Act of 1962 288
Sec. 328 of Food and Agriculture Act of 1962 288
AGRICULTURAL MARKETING AGREEMENT ACT OF 1937:
Sec. 1. Reenactment of provisions of Agricultural Adjustment Act 289
(a) Sec. 1. Declaration of emergency 289
(b) Sec. 2. Declaration of policy 289
(c) Sec. 8a (5), (6), (7), (8), and (9). Violations and enforcement 290
(d) Sec. 8b. Marketing agreements 291
(e) Sec. 8c. Orders 291
(1) Orders 291
(2) Commodities to which applicable 291
(3) Notice and hearing 293
(4) Finding and issuance of order 293
(5) Terms—milk and its products 293
(6) Terms—other commodities 294
(7) Terms common to all orders 297
(8) Orders with marketing agreement 297
(9) Orders with or without marketing agreement 298
(10) Manner of regulation and applicability 299
(11) Regional application 299
(12) Cooperative association representation 300
(13) Retailer and producer exemption 300
(14) Violation of order 300
(15) Petition by handler and review 300
(16) Termination of orders and marketing agreements 301
(17) Provisions applicable to amendments 302
(18) Milk prices 302
(19) Producer referendum 302
(f) Sec. 8d. Books and records 303
(g) Sec. 8e. Restrictions on imported commodities 304
(h) Sec. 10 (a), (b)(2), (c), (f), (g), (h), and (i). Miscellaneous 305
(i) Sec. 12 (a) and (c). Appropriation and administrative expenses 308
(j) Sec. 14. Separability of provisions 308
(k) Sec. 22. Imports 309
Sec. 2. Amendments to Agricultural Adjustment Act 309
Sec. 3. Arbitration of disputes concerning milk 309
Sec. 4. Agreements, etc., unaffected 309
Sec. 5. Taxes under Agricultural Adjustment Act; provisions unaffected 310
Sec. 6. Short title 310
NATIONAL SCHOOL LUNCH ACT:
Sec. 1. Short title 311
Sec. 2. Declaration of policy 311
Sec. 3. Appropriations authorized 311
Sec. 4. Apportionments to States 311
Sec. 5. Nonfood assistance 312
Sec. 6. Direct federal expenditures 312
Sec. 7. Payments to States 313
Sec. 8. State disbursement to schools 313
Sec. 9. Nutritional and other program requirements 314
Sec. 10. Nonprofit private schools 314
Sec. 11. Special assistance 315
Sec. 12. Miscellaneous provisions and definitions 316
FOOD STAMP ACT OF 1964:
Sec. 1. Short title 319
Sec. 2. Declaration of policy 319
Sec. 3. Definitions 319
Sec. 4. Establishment of the food stamp program 320

PART VII. MISCELLANEOUS LAWS—Continued

FOOD STAMP ACT OF 1964—Continued — Page
Sec. 5. Eligible households — 320
Sec. 6. Issuance and use of coupons — 321
Sec. 7. Value of the coupon allotment and charges to be made — 321
Sec. 8. Approval of retail food stores and wholesale food concerns — 321
Sec. 9. Redemption of coupons — 322
Sec. 10. Administration — 322
Sec. 11. Disqualification of retail food stores and wholesale food concerns — 323
Sec. 12. Determination and disposition of claims — 324
Sec. 13. Administrative and judicial review — 324
Sec. 14. Violations and enforcement — 325
Sec. 15. Cooperation with State agencies — 325
Sec. 16. Appropriations — 326
DECLARATIONS OF POLICY:
Agricultural Act of 1961. Sec. 2 — 327
Food and Agriculture Act of 1962. Sec. 402 — 327
Agricultural Act of 1954. Sec. 204 — 328
AGRICULTURAL ACT OF 1961. Sec. 102. Consultation on Agricultural programs —
AGRICULTURAL ACT OF 1954. Sec. 601. Agricultural attaches — 329
ESTABLISHMENT OF FEDERAL AGRICULTURAL SERVICES TO GUAM — 329
ACT OF DECEMBER 20, 1944. Compromising, adjusting, or cancelling debts — 330
PUB. LAW 664. CARGO PREFERENCE ACT — 333
ACT OF AUGUST 27, 1953. Sec. 3. Humane Methods of Slaughter Act — 334

PART VIII. DEPARTMENT OF AGRICULTURE AND RELATED AGENCIES APPROPRIATION ACT

TITLE I. GENERAL ACTIVITIES

AGRICULTURAL RESEARCH SERVICE — 335
Salaries and expenses — 335
Salaries and expenses (special foreign currency program) — 336
SOIL CONSERVATION SERVICE — 336
Great Plains conservation program — 336
AGRICULTURAL MARKETING SERVICE — 336
Special milk program — 336
School lunch program — 337
Removal of surplus Agricultural Commodities (Sec. 32) — 337
FOREIGN AGRICULTURAL SERVICE — 337
Salaries and expenses — 337
AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE — 338
Expenses — 338
Sugar Act — 338
Agricultural conservation program — 338
Conservation reserve program — 339
Cropland conversion program — 340
Emergency conservation measures — 340

TITLE II. CORPORATIONS

FEDERAL CROP INSURANCE CORPORATION — 340
Administrative and operating expenses — 340
Federal crop insurance corporation fund — 340

PART VIII. DEPARTMENT OF AGRICULTURE AND RELATED AGENCIES APPROPRIATION ACT—Con.

Page

COMMODITY CREDIT CORPORATION 340
Reimbursement for net realized losses 340
Reimbursement for special milk program .....
Limitation on administrative expenses 341
Public Law 480 341
International Wheat Agreement 341
Bartered materials for supplemental stockpile 341

TITLE V. GENERAL PROVISIONS

Sec. 601. Purchase of motor vehicles 342
Sec. 602. Employment of aliens 342
Sec. 603. Funds available for uniforms or allowances 342
Sec. 604. Predicting prices of cotton 342
Sec. 605. Purchase of twine 342
Sec. 606. Contracting 342

SOIL CONSERVATION AND DOMESTIC ALLOTMENT ACT, AS AMENDED

EXPLANATORY NOTE

Sections 1 to 6, which were enacted April 27, 1935 (49 Stat. 163), vested certain powers in the Secretary of Agriculture with respect to the control and prevention of soil erosion and provided for the Soil Conservation Service to be established as the agency to exercise such powers.

Sections 7 to 17 were enacted February 29, 1936 (49 Stat. 1148), to replace, in part, certain provisions of the Agricultural Adjustment Act (of 1933) which were invalidated by the Supreme Court on January 6, 1936. Section 17 provides that the entire Act may be cited as the "Soil Conservation and Domestic Allotment Act." Under the agricultural conservation program formulated pursuant to sections 7 to 17 of the Act, farmers are assisted through payments and grants of aid in carrying out approved soil and water conservation measures. Section 16(b) was enacted August 7, 1956 (70 Stat. 1115), to provide specifically for a conservation program in the States of the Great Plains. In 1960, the Great Plains provisions of the Act were amended to provide for the preservation of acreage allotments and quotas for land under contract pursuant to this program (Pub. L. 86–793, 74 Stat. 1030, approved September 14, 1960). In 1961, the Act was amended to add section 16(c) to provide for a Feed Grain Program (Pub. L. 87–5, March 22, 1961). Section 16(d) was added by Pub. L. 87–128 (75 Stat. 300), approved August 8, 1961 to provide for a special conservation program for 1962. Sections 16 (e), (f), and (g) were added by Pub. L. 87–703, 76 Stat. 606, approved September 27, 1962. Section 16(h) was added by Pub. L. 88–26, 77 Stat. 45, approved May 20, 1963. Pub. L. 87–732, 16 U.S.C. 590p, approved October 2, 1962 added Sec. 16A which restricts the use of public funds for the drainage of wetlands in the States of North Dakota, South Dakota, and Minnesota.

Originally the States were given the opportunity to submit State plans for the administration of the conservation program pursuant to section 4 of the Act. However, only one State submitted a plan which was unacceptable. The Congress had on many occasions extended the authority of the Secretary to conduct the conservation program, pursuant to section 4 of the Act so as to provide the States additional time to submit these plans. The Secretary's authority was to expire on December 31, 1962, and the Congress repealed the State Plans provisions of the Act and granted the Secretary continuing authority to carry out the agricultural conservation program on a national basis. (Pub. L. 87–703, 76 Stat. 605.)

PART I

SOIL CONSERVATION AND DOMESTIC ALLOTMENT ACT,[1] AS AMENDED

AN ACT

To provide for the protection of land resources against soil erosion, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is hereby recognized that the wastage of soil and moisture resources on farm, grazing, and forest lands of the Nation, resulting from soil erosion, is a menace to the national welfare and that it is hereby declared to be the policy of Congress to provide permanently for the control and prevention of soil erosion and thereby to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors, protect public health, public lands and relieve unemployment, and the Secretary of Agriculture, from now on, shall coordinate and direct all activities with relation to soil erosion and in order to effectuate this policy is hereby authorized, from time to time—

(1) To conduct surveys, investigations, and research relating to the character of soil erosion and the preventive measures needed, to publish the results of any such surveys, investigations, or research, to disseminate information concerning such methods, and to conduct demonstrational projects in areas subject to erosion by wind or water;

(2) To carry out preventive measures, including, but not limited to, engineering operations, methods of cultivation, the growing of vegetation, and changes in use of land;

(3) To cooperate or enter into agreements with, or to furnish financial or other aid to, any agency, governmental or otherwise, or any person, subject to such conditions as he may deem necessary, for the purposes of this Act; and

(4) To acquire lands, or rights or interests therein, by purchase, gift, condemnation, or otherwise, whenever necessary for the purposes of this Act. (16 U.S.C. 590a.)

LANDS ON WHICH PREVENTIVE MEASURES MAY BE TAKEN

SEC. 2. The acts authorized in section 1 (1) and (2) may be performed—

(a) On lands owned or controlled by the United States or any of its agencies, with the cooperation of the agency having jurisdiction thereof; and

(b) On any other lands, upon obtaining proper consent or the necessary rights or interests in such lands. (16 U.S.C. 590b.)

[1] Pub. L. 46, 74th Cong., 49 Stat. 163, approved April 27, 1935.

BENEFITS FOR NON-GOVERNMENT CONTROLLED LANDS

SEC. 3. As a condition to the extending of any benefits under this Act to any lands not owned or controlled by the United States or any of its agencies, the Secretary of Agriculture may, insofar as he may deem necessary for the purposes of this Act, require—

(1) The enactment and reasonable safeguards for the enforcement of State and local laws imposing suitable permanent restrictions on the use of such lands and otherwise providing for the prevention of soil erosion;

(2) Agreements or covenants as to the permanent use of such lands; and

(3) Contributions in money, services, materials, or otherwise, to any operations conferring such benefits. (16 U.S.C. 590c.)

PERSONNEL

SEC. 4. For the purposes of this Act, the Secretary of Agriculture may—

(1) Secure the cooperation of any governmental agency;

(2) Subject to the provisions of the civil-service laws and the Classification Act of 1949, appoint and fix the compensation of such officers and employees as he may deem necessary, except for a period not to exceed eight months from the date of this enactment, the Secretary of Agriculture may make appointments and may continue employees of the organization heretofore established for the purpose of administering those provisions of the National Industrial Recovery Act which relate to the prevention of soil erosion, without regard to the civil-service laws or regulations and the Classification Act of 1949, as amended; and any person with technical or practical knowledge may be employed and compensated under this Act on a basis to be determined by the Civil Service Commission; and

(3) Make expenditures for personal services and rent in the District of Columbia and elsewhere, for the purchase of lawbooks and books of reference, for printing and binding, for the purchase, operation, and maintenance of passenger-carrying vehicles, and perform such acts, and prescribe such regulations, as he may deem proper to carry out the provisions of this Act. (16 U.S.C. 590d.)

ESTABLISHMENT OF SOIL CONSERVATION SERVICE

SEC. 5. The Secretary of Agriculture shall establish an agency to be known as the "Soil Conservation Service," [2] to exercise the powers conferred on him by this Act and may utilize the organization heretofore established for the purpose of administering those provisions of sections 202 and 203 of the National Industrial Recovery Act which relate to the prevention of soil erosion, together with such personnel thereof as the Secretary of Agriculture may determine, and all unex-

[2] Functions of Soil Conservation Service in Department of Agriculture with respect to soil and moisture conservation operations conducted on lands under jurisdiction of Department of the Interior were transferred to the Department of the Interior, to be administered by the Secretary of the Interior through such agencies in the Department of the Interior as the Secretary shall designate, by Reorganization Plan No. IV, Sec. 6, effective June 30, 1940, 5 F.R. 2421, 54 Stat. 1235, 5 U.S.C. 133t note.

pended balances of funds heretofore allotted to said organization shall be available until June 30, 1937, and the Secretary of Agriculture shall assume all obligations incurred by said organization prior to transfer to the Department of Agriculture. In order that there may be proper coordination of erosion-control activities the Secretary of Agriculture may transfer to the agency created under this Act such functions, funds, personnel, and property of other agencies in the Department of Agriculture as he may from time to time determine. (16 U.S.C. 590e.)

APPROPRIATION AUTHORIZED

SEC. 6. There are hereby authorized to be appropriated for the purposes of this Act such sums as Congress may from time to time determine to be necessary.

Appropriations for carrying out this Act allocated for the production or procurement of nursery stock by any Federal agency, or funds appropriated to any Federal agency for allocation to cooperating States for the production or procurement of nursery stock, shall remain available for expenditure for not more than 3 fiscal years. (16 U.S.C. 590f.)

[Department of Agriculture Organic Act of 1944. SEC. 302. (b) The Soil Conservation Service subject to applicable regulations under the Federal Property and Administrative Services Act of 1949, as amended, may sell and distribute supplies, materials, and equipment to other Government activities, the cost of such supplies and materials or the value of such equipment (including the cost of transportation and handling) to be reimbursed to appropriations current at the time additional supplies, materials, or equipment are procured from the appropriations chargeable with the cost or value of such supplies, materials, or equipment.[3] (16 U.S.C. 590q–1.)]

AGRICULTURAL CONSERVATION POLICY AND ENUMERATION OF PURPOSES

SEC. 7. (a) It is hereby declared to be the policy of this Act also to secure, and the purposes of this Act shall also include, (1) preservation and improvement of soil fertility; (2) promotion of the economic use and conservation of land; (3) diminution of exploitation and wasteful and unscientific use of national soil resources; (4) the protection of rivers and harbors against the results of soil erosion in aid of maintaining the navigability of waters and water courses and in aid of flood control; and (5) reestablishment, at as rapid a rate as the Secretary of Agriculture determines to be practicable and in the general public interest, of the ratio between the purchasing power of the net income per person on farms and that of the income per person not on farms that prevailed during the five-year period August 1909–July 1914, inclusive, as determined from statistics available in the United States Department of Agriculture, and the maintenance of such ratio. The powers conferred under sections 7 to 14, inclusive, of this Act shall be used to assist voluntary action calculated to effectuate the purposes specified in this section. Such powers shall not be used to

[3] Act of September 21, 1944, 58 Stat. 738, amended by Act of October 31, 1951, 65 Stat. 707.

discourage the production of supplies of foods and fibers sufficient to maintain normal domestic human consumption as determined by the Secretary from the records of domestic human consumption in the years 1920 to 1929, inclusive, taking into consideration increased population, quantities of any commodity that were forced into domestic consumption by decline in exports during such period, current trends in domestic consumption and exports of particular commodities, and the quantities of substitutes available for domestic consumption within any general class of food commodities. In carrying out the purposes of this section due regard shall be given to the maintenance of a continuous and stable supply of agricultural commodities adequate to meet consumer demand at prices fair to both producers and consumers. (16 U.S.C. 590g(a).)

Sec. 7(b)–(g)[4] * * *

AUTHORITY OF SECRETARY TO MAKE PAYMENTS OR GRANTS OF AID DIRECTLY TO FARMERS

SEC. 8. (a)[5] * * *

(b)[6] The Secretary shall have power to carry out the purposes specified in clauses (1), (2), (3), (4), and (5) of section 7(a) by making payments or grants of other aid to agricultural producers, including tenants and sharecroppers, in amounts determined by the Secretary to be fair and reasonable in connection with the effectuation of such purposes during the year with respect to which such payments or grants are made, and measured by (1) their treatment or use of their land, or a part thereof, for soil restoration, soil conservation, or the prevention of erosion; (2) changes in the use of their land; (3) their equitable share, as determined by the Secretary, of the normal national production of any commodity or commodities required for domestic consumption; or (4) their equitable share, as determined by the Secretary, of the national production of any commodity or commodities required for domestic consumption and exports adjusted to reflect the extent to which their utilization of cropland on the farm conforms to farming practices which the Secretary determines will best effectuate the purposes specified in section 7(a); or (5) any combination of the above. Clauses (1) and (2) above shall be construed to cover water conservation and the beneficial use of water on individual farms, including measures to prevent runoff, the building of check dams and ponds, and providing facilities for applying water to the land. In determining the amount of any payment or grant measured by (1) or (2) the Secretary shall take into consideration the productivity of the land affected by the farming practices adopted during the year with respect to which such payment is made. In carrying out the provisions of this section in the States of the Union, except Alaska,[7]

[4] Sec. 7(b)–(g) repealed by the Food and Agriculture Act of 1962, 76 Stat. 605, approved September 27, 1962.

[5] Sec. 8(a) repealed by the Food and Agriculture Act of 1962, 76 Stat. 605, approved September 27, 1962.

[6] Sentences 7 through 11 were added in lieu of other language which was deleted by Pub. L. 88–534, 78 Stat. 742, approved August 31, 1964, and are effective for elections of committeemen held on or after January 1, 1965. Subsec. (b) was previously amended by the Food and Agriculture Act of 1962, 76 Stat. 605, approved September 27, 1962.

[7] The words "States of Union, except Alaska" substituted for previous language by the Act of July 12, 1960, 74 Stat. 412.

the Secretary is directed to utilize the services of local and State committees selected as hereinafter provided. The Secretary shall designate local administrative areas as units for administration of programs under this section. No such local area shall include more than one county or parts of different counties. Farmers within any such local administrative area, and participating or coooperating in programs administered within such area, shall elect annually from among their number a local committee of not more than three members for such area. The members of the local committees shall, in a county convention, nominate and elect a county committee which shall consist of three members who are farmers in the county. At the first county convention held on or after the effective date of this sentence, one member of the county committee shall be elected for one year; one member shall be elected for two years; and one member shall be elected for three years. Thereafter, each member of a county committee shall be elected for a term of three years. No member of the county committee shall be elected for more than three consecutive terms (exclusive of any term which began prior to the effective date of this sentence). The local committee shall select a secretary and may utilize the county agricultural extension agent for such purpose. The county committee shall select a secretary who may be the county agricultural extension agent. If such county agricultural extension agent shall not have been elected secretary of such committee, he shall be ex officio a member of the county committee. The county agricultural extension agent shall not have the power to vote. In any county in which there is only one local committee the local committee shall also be the county committee. In each State there shall be a State committee for the State composed of not less than three or more than five farmers who are legal residents of the State and who are appointed by the Secretary. The State director of the Agricultural Extension Service shall be ex officio a member of such State committee. The ex officio members of the county and State committees shall be in addition to the number of members of such committee, hereinbefore specified. The Secretary shall make such regulations as are necessary relating to the selection and exercise of the functions of the respective committees, and to the administration, through such committees, of such programs. In carrying out the provisions of this section, the Secretary shall, as far as practicable, protect the interests of tenants and sharecroppers; is authorized to utilize the agricultural extension service and other approved agencies; shall accord such recognition and encouragement to producer-owned and producer-controlled cooperative associations as will be in harmony with the policy toward cooperative associations set forth in existing Acts of Congress and as will tend to promote efficient methods of marketing and distribution; shall not have power to acquire any land or any right of interest therein; shall, in every practicable manner, protect the interests of small producers; and shall in every practical way encourage and provide for soil-conserving and soil-rebuilding practices rather than the growing of soil-depleting crops. Rules and regulations governing payments or grants under this subsection shall be as simple and direct as possible, and, wherever practicable, they shall be classified on two bases: (a) Soil-depleting crops and practices, (b) soil-building crops and practices.

Notwithstanding any other provision of law, in making available conservation materials consisting of seeds, seed inoculants, fertilizers, liming and other soil-conditioning materials, trees, or plants, or in making available soil-conserving or soil-building services, to agricultural producers under this subsection, the Secretary may make payments in advance of determination of performance by the producers, to persons who fill purchase orders covering approved conservation materials or covering soil-conserving or soil-building services, furnished to producers, or who render services to the Secretary in delivering to producers approved conservation materials, for the carrying out, by the prodcers, of soil-building or soil-conserving practices approved by the Secretary. The price at which purchase orders for any conservation materials or services are filled may be limited to a fair price fixed in accordance with regulations prescribed by the Secretary.

Appropriations are hereby authorized for the purchase in advance of the program year for which the appropriation is made of seeds, fertilizers, lime, trees, or any other farming materials or any soil-terracing services, and making grants thereof to agricultural producers to aid them in carrying out farming practices approved by the Secretary in programs under this Act; for the reimbursement of any Federal, State, or local government agency for fertilizers, seeds, lime, trees, or other farming materials, or any soil-terracing services, furnished by such agency; and for the payment of all expenses necessary in making such grants, including all or part of the costs incident to the delivery thereof. (16 U.S.C. 590h(b).)

[Department of Agriculture Organic Act of 1956. Sec. 6(b) Payments of grants under sections 7 to 17 of the Soil Conservation and Domestic Allotment Act, as amended, may be conditioned upon the utilization of land with respect to which such payments or grants are to be made in conformity with farming practices which will encourage and provide for soil-building and soil- and water-conserving practices in the most practical and effective manner and adapted to conditions in the several States, as determined and approved by the State committes appointed pursnant to section 8(b) of such Act, for the respective States.[8] (16 U.S.C. 590h–4.)]

[Public Law 85–278 (71 Stat. 601)—That, notwithstanding the provisions of subsection (b) of section 8 of the Soil Conservation and Domestic Allotment Act, two county committees shall be elected annually under such subsection for the counties of Otter Tail, Polk, and Saint Louis, in the State of Minnesota, and for the county of Pottawattamie, in the State of Iowa, and that the actions heretofore or hereafter taken by each of such committees shall be given the same effect in the area served by it as is given to the actions of the county committee in a county served by a single county committee. (16 U.S.C. 590h note.)]

APPORTIONMENT OF ACREAGE ALLOTMENTS

(c) (1) In apportioning acreage allotments under this section in the case of wheat and corn, the National and State allotments and

[8] Act of August 3, 1956, 70 Stat. 1033.

the allotments to counties shall be apportioned annually on the basis of the acreage seeded for the production of the commodity during the ten calendar years immediately preceding the calendar year in which the national acreage allotment is determined (plus, in applicable years, the acreage diverted under previous agricultural adjustment and conservation programs), with adjustments for abnormal weather conditions and trends in acreage during the applicable period.

(2) [9] In the case of wheat, the allotment to any county shall be apportioned annually by the Secretary, through the local committees, among the farms within such county on the basis of tillable acres, crop-rotation practices, type of soil, and topography. Not more than 3 per centum of such county allotment shall be apportioned to farms on which wheat has not been planted during any of the three marketing years immediately preceding the marketing year in which the allotment is made. Notwithstanding any other provision of this section, the allotments established, or which would have been established, for any farm acquired in 1940 or thereafter by the United States for national-defense purposes shall be placed in an allotment pool and shall be used only to establish allotments for other farms owned or acquired by the owner of the farm so acquired by the United States. The allotments so made for any farm, including a farm on which wheat has not been planted during any of the three marketing years preceding the marketing year in which the allotment is made shall compare with the allotments established for other farms in the same area which are similar except for the past acreage of wheat. (16 U.S.C. 590h(c).)

(3) In the case of corn, the allotment to any county shall be apportioned annually by the Secretary, through the local committees, among the farms within such county on the basis of tillable acreage, type of soil, topography, and crop-rotation practices.

(4) [10] * * *

(5) In determining normal yield per acre for any county under this section in the case of wheat or corn, the normal yield shall be the average yield per acre therein for such commodity during the ten calendar years immediately preceding the calendar year in which such yield is determined, adjusted for abnormal weather conditions and trends in yields. If for any reason, there is no actual yield, or the data therefor are not available for any year, then an appraised yield for such year, determined in accordance with regulations of the Secretary, shall be used. If, on account of drought, flood, insect pests, plant disease, or other uncontrollable natural causes, the yield in any year of such ten-year period is less than 75 per centum of the average (computed without regard to such year), such year shall be eliminated in calculating the normal yield per acre. Such normal yield per acre for any county need be redetermined only when the actual average yield for the ten calendar years immediately pre-

[9] See Sec. 201 of Pub. L. 88–297, 78 Stat. 178, approved April 11, 1964, regarding the 1965 acreage allotment on wheat on p. 55.

[10] Repealed by the Act of April 10, 1939, 53 Stat. 573.

ceding the calendar year in which such yield is being reconsidered differs by at least 5 per centum from the actual average yield for the ten years upon which the existing normal yield per acre for the county was based.

(6) In determining normal yield per acre for any farm under this section in the case of wheat or corn, the normal yield shall be the average yield per acre thereon for such commodity during the ten calendar years immediately preceding the calendar year in which such yield is determined, adjusted for abnormal weather conditions and trends in yields. If for any such year the data are not available, or there is no actual yield, then the normal yield for the farm shall be appraised in accordance with regulations of the Secretary, taking into consideration abnormal weather conditions, the normal yield for the county, and the yield in years for which data are available. (16 U.S.C. 590h(c).)

CONDITIONS AFFECTING PAYMENTS OR GRANTS OF AID

(d) Any payment or grant of aid made under subsection (b) shall be conditioned upon the utilization of the land, with respect to which such payment is made, in conformity with farming practices which the Secretary finds tend to effectuate any one or more of the purposes specified in clause (1), (2), (3), (4), or (5) of section 7(a).

Any payment made under subsection (b) with respect to any farm (except for lands which the Secretary determines should not be utilized for the harvesting of crops but should be permanently used for grazing purposes only) shall, if the number of cows kept on such farm, and in the county in which such farm is located, for the production of milk or products thereof (for market), exceeds the normal number of such cows, be further conditioned upon the utilization of the land, with respect to which such payment is made, so that soil-building and soil-conserving crops planted or produced on an acreage equal to the land normally used for the production of soil-depleting crops, but, as a condition of such payment, not permitted to be so used, shall be used for the purpose of building and conserving the fertility of the soil, or for the production of agricultural commodities to be consumed on the farm, and not for market. Whenever it is determined that a county, as a whole, is in substantial compliance with the provisions of this paragraph, no payment shall be denied any individual farmer in the county by reason of this paragraph; and no payment shall be denied a farmer by reason of this paragraph unless it has been determined that the farmer has not substantially complied with the provisions of this paragraph. Whenever the Secretary finds that by reason of drought, flood, or other disaster, a shortage of feed exists in any area, he shall so declare, and to the extent and for the period he finds necessary to relieve such shortage, the operation of the condition provided in this paragraph shall be suspended in such area and, if necessary to relieve such shortage, in other areas defined by him. As used in this paragraph, the term "for market" means for disposition by sale, barter, or exchange, or by feeding (in any form) to dairy livestock which, or the products of which, are to be sold, bartered or exchanged; and such term shall not include consumption on the farm. An agricultural commodity shall be deemed consumed

on the farm if consumed by the farmer's family, employees, or household, or if fed to poultry or livestock other than dairy livestock on his farm; or if fed to dairy livestock on his farm and such dairy livestock, or the products thereof, are to be consumed by his family, employees, or household. Whenever the Secretary has reason to believe the income of producers of livestock (other than dairy cattle) or poultry in any area from such sources is being adversely affected by increases in the supply for market of such livestock or poultry, as the case may be, arising as a result of programs carried out under this Act, he shall make an investigation with respect to the existence of such facts. If, upon investigation, the Secretary finds that the income of producers of such livestock, or poultry, as the case may be, in any area from any such source is being adversely affected by such increases, he shall, as soon as practicable, make such provision in the administration of this Act with respect to the use of diverted acres as he may find necessary to protect the interests of producers of such livestock or poultry in the affected area. (16 U.S.C. 590h(d).)

DIVISION OF PAYMENTS AMONG LANDLORDS, TENANTS, AND SHARECROPPERS

(e) Payments made by the Secretary to farmers under subsection (b) shall be divided among the landlords, tenants, and sharecroppers of any farm, with respect to which such payments are made, in the same proportion that such landlords, tenants, and sharecroppers are entitled to share in the proceeds of the agricultural commodity with respect to which such payments are made, or, effective with respect to the 1942 and subsequent farm programs, in the event of acquisition of title to, or lease of, any farm for use in connection with the national war effort which caused the producers on such farms to lose, prior to the time of harvest, their interests in the crops planted thereon, or the proceeds thereof, payments with respect to such crops, to the extent that full compensation for the loss of payments with respect thereto in connection with such acquisition or lease was not made to such producers, shall be divided among the landlords, tenants, and sharecroppers on such farm in the proportion which it is determined that such producers would have been entitled to share in the proceeds of such crops but for such acquisition or lease: *Provided*, That payments based on soil-building or soil-conserving practices shall be divided in proportion to the extent which such landlords, tenants, and sharecroppers contribute to the carrying out of such practices. Such payments shall be paid by the Secretary directly to the landlords, tenants, or sharecroppers entitled thereto, and shall be computed at rates which will permit the Secretary to set aside out of the funds available for the making of such payments for each year an amount sufficient to permit the increases herein specified to be made within the limits of the funds so available. If with respect to any farm the total payment to any person for any year would be:

(1) Not more than $20, the payment shall be increased by 40 per centum;

(2) More than $20 but not more than $40, the payment shall be increased by $8, plus 20 per centum of the excess over $20;

(3) More than $40 but not more than $60, the payment shall be increased by $12, plus 10 per centum of the excess over $40;

(4) More than $60 but not more than $186, the payment shall be increased by $14; or

(5) More than $186 but less than $200, the payment shall be increased to $200.

In the case of payments of more than $1, the amount of the payment which shall be used to calculate the 40-, 20-, and 10-per-centum increases under clauses (1), (2), and (3) shall not include that part, if any, of the payment which is a fraction of a dollar.

Beginning with the calendar year 1939, no total payment for any year to any person under such subsection (b) shall exceed $10,000. In the case of payments made to any individual, partnership, or estate on account of performance on farms in different States, Territories, or possessions, the $10,000 limitation shall apply to the total of the payments for each State, Territory, or possession, for a year and not to the total of all such payments.

Persons who carry out farming operations as tenants or sharecroppers on cropland owned by the United States Government and who comply with the terms and conditions of the conservation program, formulated pursuant to sections 7 to 17, inclusive, of this Act, as amended, shall be entitled to apply for and receive payments, or to retain payments heretofore made, for their participation in said program to the same extent as other producers. Persons who carry out conservation practices on federally owned noncropland which directly conserve or benefit nearby or adjoining privately owned lands of such persons and who maintain and use such Federal land under agreement with the Federal agency having jurisdiction thereof and who comply with the terms and conditions of the agricultural conservation program formulated pursuant to sections 7 to 17 of this Act, as amended, shall be entitled to apply for and receive payments under such program to the same extent as other producers. (16 U.S.C. 590h(e).)

CHANGE BETWEEN LANDLORD AND TENANTS OR SHARECROPPERS AFFECTING LANDLORD'S PAYMENTS

(f) Any change in the relationship between the landlord and the tenants or sharecroppers, with respect to any farm, that would increase over the previous year the amount of payments or grants of other aid under subsection (b) that would otherwise be made to any landlord shall not operate to increase such payment or grant to such landlord. Any reduction in the number of tenants below the average number of tenants on any farm during the preceding three years that would increase the payments or grants of other aid under such subsection that would otherwise be made to the landlord shall not hereafter operate to increase any such payment or grant to such landlord. Such limitations shall not apply if on investigation the local committee finds that the change is justified and approves such change in relationship or reduction. Such action of local committees shall be subject to approval or disapproval by State committees. (16 U.S.C. 590h(f).)

ASSIGNMENT OF PAYMENT

(g) A payment which may be made to a farmer under this section, may be assigned, without discount, by him in writing as security for cash or advances to finance making a crop. Such assignment shall be signed by the farmer and witnessed by a member of the county or other local committee, or by the treasurer or the secretary of such committee, and filed with the county agent or the county committee. Such assignment shall include the statement that the assignment is not made to pay or secure any preexisting indebtedness. This provision shall not authorize any suit against or impose any liability upon the Secretary or any disbursing agent if payment to the farmer is made without regard to the existence of any such assignment. (16 U.S.C. 590h(g).)

[NAVAL STORES CONSERVATION PROGRAM.—In administering the naval stores conservation programs authorized in section 8 and in making payments thereunder to gum naval stores producers the Secretary may utilize the services of regional associations of such producers or any agency of the Government in lieu of the State, county, and other local committees utilized in the other agricultural conservation programs if he finds that more efficient administration will result, and the provisions of section 388(b) of the Agricultural Adjustment Act of 1938 shall otherwise be applicable to the administration of said naval stores conservation programs.[11] (16 U.S.C. 590h–1.)]

[DEFERRED GRAZING PROGRAM.—PUBLIC LAW 85–25[12] (71 Stat. 26)—That notwithstanding any other provision of law, in connection with any major disaster due to drought determined by the President to warrant assistance by the Federal Government under Public Law 875, Eighty-first Congress, as amended, the President is authorized and directed as part of the assistance provided pursuant to such Act to formulate and carry out, through the facilities of the Department of Agriculture, a deferred grazing program, which shall include nonuse or limited use, or any needed combination thereof, in any county affected by such disaster in which the Secretary of Agriculture determines grazing of native rangeland is a substantial factor in agricultural production, and finds that limited or deferred grazing is necessary and appropriate for the reestablishment or conservation of grass for grazing. Such program shall be applicable only to nonfederally owned land which is normally used for grazing. Within thirty days (1) after the date of enactment of this Act, or (2) after any subsequent designation of any such area as a disaster area by the President, the Secretary shall designate the counties in any such area in which this program shall be available, and the program shall remain available in each such county for a period of not more than five years after the date of enactment of this Act.

Sec. 2. The program shall provide for payment for deferred grazing to farmers and ranchers at rates equal to the fair rental value of the land for the grazing use withheld under the program, as determined by the Secretary on the basis of the normal grazing capacity of the land during periods of adequate precipitation. No payment shall be made under the program if it is determined that a shift of livestock

[11] Act of June 16, 1938, 52 Stat. 746.
[12] Act of April 25, 1957.

from the deferred areas to other land results in overgrazing nondeferred areas. Payment to any person for deferred grazing on land in any one county or land in more than one county operated as a single unit shall not exceed $5,000 for any one year.

Sec. 3. The program authorized herein may include such terms and conditions, in addition to those specifically provided for herein, as are determined desirable to effectuate its purposes and to facilitate practical administration. The program authorized herein for any county shall be supplemental to the agricultural conservation program, and not in substitution of, other programs in such county authorized by any other law, except that no payment shall be made concurrently on the same land for deferred grazing under this and any other program.

Sec. 4. There is hereby authorized to be appropriated, in addition to other funds authorized to be appropriated for the purposes of Public Law 875, Eighty-first Congress, such funds as are necessary to carry out the program authorized herein. (42 U.S.C. 1855b note.)]

SURVEYS, INVESTIGATIONS, AND REPORTS

SEC. 9. The Secretary is authorized to conduct surveys, investigations, and research relating to the conditions and factors affecting, and methods of accomplishing most effectively, the policy and purposes of section 7(a). Notwithstanding any provision of existing law, the Secretary is authorized to make public such information as he deems necessary to carry out the provisions of this Act. The Secretary shall transmit to the Congress a report, for the fiscal year ending June 30, 1937, and for each fiscal year thereafter, of the operations for such year under sections 7 to 14, inclusive, of this Act, which report shall include a statement of the expenditures made and obligations incurred, by classes and amounts. (16 U.S.C. 590i.)

DEFINITION OF AGRICULTURAL COMMODITY

SEC. 10. The term "agricultural commodity" as used in this Act means any such commodity and any regional or market classification, type, or grade thereof. (16 U.S.C. 590j.)

AVAILABILITY OF FUNDS

SEC. 11. All funds available for carrying out this Act shall be available for allotment to the bureaus and offices of the Department of Agriculture and for transfer to such other agencies of the Federal or State Governments, or to local public agencies, as the Secretary may request to cooperate or assist in carrying out this Act, and for payments to committees or associations of producers in any region or regions to cover the estimated administrative expenses to be incurred by any such committee or association in cooperating in carrying out this Act: *Provided*, That the Secretary may prescribe that all or part of such estimated expenses of any such committee or association may be deducted pro rata from the payments or grants made to the members thereof: *Provided further*, That the Secretary may make such payments in advance of determination of performance: *Provided*

further, That the transfer of funds for services of technicians in formulating and carrying out agricultural conservation programs, from allotments for agricultural conservation payments within a State, shall be subject to such limitations and conditions as may be provided in appropriation or other law. Funds so transferred may be placed in a single account for each state. (16 U.S.C. 590k.)

EXPANSION OF MARKETS FOR AGRICULTURAL COMMODITIES AND ADVANCING FUNDS TO FEDERAL CROP INSURANCE CORPORATION

SEC. 12. (a) Whenever the Secretary finds that the exercise of the powers conferred in this section will tend to carry out the purpose specified in clause (5) of section 7(a), or will tend to provide for and maintain a continuous and stable supply of agricultural commodities adequate to meet consumer demand at prices fair to both producers and consumers, or both, he shall use such part as he deems necessary of the sums appropriated to carry out this Act for the expansion of domestic and foreign markets or for seeking new or additional markets for agricultural commodities or the products thereof or for the removal or disposition of surpluses of such commodities or the products thereof. (16 U.S.C. 590*l*(a).)

(b) The Secretary is authorized to make advances to producers for the purpose of assisting them to insure their crops with the Federal Crop Insurance Corporation. The Secretary shall remit the amount of any such advances to a producer directly to such Corporation in payment of the premium on the insurance for which the producer has made application. Advances shall only be made to producers who are participating or who agree to participate in a program formulated pursuant to section 8. Except as otherwise provided in this subsection, the terms and conditions of such advances shall be fixed by the Secretary. In carrying out the provisions of this subsection, the Secretary may transfer to the Federal Crop Insurance Corporation, prior to the execution of applications for insurance or requests for advances by producers, the funds estimated as necessary to cover the advances which will be requested for the payment of premiums under a crop-insurance program, and any portion of such funds not used for advances to producers under such program shall be returned to the Secretary by the Federal Crop Insurance Corporation. (16 U.S.C. 590*l*(b).)

EXECUTION OF POWERS OF SECRETARY BY PRODUCTION AND MARKETING ADMINISTRATION

SEC. 13. Notwithstanding the foregoing provisions of this Act, the Secretary is authorized and directed to provide for the execution by the Production and Marketing Administration of such powers conferred upon him under sections 7 to 14, inclusive, of this Act as he deems may be appropriately exercised by such Administration, and for such purposes the provisions of law applicable to the appointment and compensation of persons employed by the Production and Marketing Administration shall apply. (16 U.S.C. 590m.)

758-820—65——3

FINALITY OF DETERMINATIONS

SEC. 14. The facts constituting the bases for any payment or grant or the amount thereof authorized to be made under section 7 or 8 hereof, when officially determined in conformity with rules or regulations prescribed by the Secretary of Agriculture, shall be reviewable only by the Secretary of Agriculture. Payments to claimants under sections 7 to 17, inclusive, of this Act may be made upon the certificate of the claimant, which certificate shall be in such form as the Secretary of Agriculture may prescribe, that he has carried out the conservation practice or practices and has complied with all other requirements as conditions for such payments and that the statements and information contained in the application for payment are correct and true, to the best of his knowledge and belief, under the penalties of title 18, United States Code. (16 U.S.C. 590n.)

APPROPRIATIONS AUTHORIZATIONS AND ALLOCATION OF FUNDS

SEC. 15. To enable the Secretary of Agriculture to carry out the purposes of sections 7 and 8 there is hereby authorized to be appropriated for any fiscal year not exceeding $500,000,000.

The funds available for payments (after allowing for estimated administrative expenses, and not to exceed 5 per centum for payments with respect to range lands, noncrop pasture lands, and naval stores) shall be allocated among the commodities produced with respect to which payments or grants are to be computed. In allocating funds among the commodities the Secretary shall take into consideration and give equal weight to (1) the average acreages planted to the various commodities (including rotation pasture), for the ten years 1928 to 1937, adjusted for abnormal weather and other conditions, including acreage diverted from production under the agricultural adjustment and soil conservation programs; (2) the value at parity prices of the production from the allotted acreages of the various commodities for the year with respect to which the payment is made; (3) the average acreage planted to the various commodities during the ten years 1928 to 1937, including the acreage diverted from production under the agricultural adjustment and soil conservation programs, in excess of the allotted acreage for the year with respect to which the payment is made; and (4) the value based on average prices for the preceding ten years of the production of the excess acreage determined under item (3). The rate of payment used in making payments to the producers of each commodity shall be such that the estimated payments with respect to such commodity shall equal the amount of funds allocated to such commodity as herein provided. For the purpose of allocating funds and computing payments or grants the Secretary is authorized to consider as a commodity a group of commodities or a regional or market classification of a commodity. For the purpose of computing payments or grants, the Secretary is authorized to use funds allocated to two or more commodities produced on farms of a designated regional or other classification to compute payments with respect to one of such commodities on such farms, and to use funds, in an amount equal to the estimated payments which would be made in

any county, for making payments pursuant to a special program under section 8 approved by the Secretary for such county: *Provided*, That farm acreage allotments shall be made for wheat in 1938, but in determining compliance wheat shall be considered in the group with other crops for which special acreage allotments are not made. Notwithstanding the foregoing provisions of this section and the provisions of section 7(g), programs of soil building practices and soil- and water-conserving practices shall be based on a distribution of the funds available for payments and grants among the several States in accordance with their conservation needs, as determined by the Secretary, except that the proportion allocated to any State shall not be reduced by more than 15 per centum from the distribution of such funds for the next preceding program year. In carrying out such programs, the Secretary shall give particular consideration to conservation problems on farm lands diverted from crops under acreage allotment programs and to the maintenance of a proper balance between soil conserving and soil depleting crops on the farm. (16 U.S.C. 590o.)

LIMITATION ON OBLIGATIONS INCURRED

SEC. 16. (a) The obligations incurred for the purpose of carrying out for any calendar year, the provisions of sections 7 to 14, inclusive, of this Act shall not exceed $500,000,000. (16 U.S.C. 590p(a).)

GREAT PLAINS CONSERVATION PROGRAM

(b) Notwithstanding any other provision of law—

(1) the Secretary is authorized, within the amounts of such appropriations as may be provided therefor, to enter into contracts of not to exceed ten years with producers in the Great Plains area determined by him to have control for the contract period of the farms or ranches covered thereby. Such contracts shall be designed to assist farm and ranch operators to make, in orderly progression over a period of years, changes in their cropping systems and land uses which are needed to conserve the soil and water resources of their farms and ranches and to install the soil and water conservation measures needed under such changed systems and uses. Such contracts may be entered into during the period ending not later than December 31, 1971, with respect to farms and ranches in counties in the Great Plains area of the States of Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming, designated by the Secretary as susceptible to serious wind erosion by reason of their soil types, terrain, and climatic and other factors.[13] The producer shall furnish to the Secretary a plan of farming operations which incorporates such soil and water conservation practices and principles as may be determined by him to be practicable for maximum mitigation of climatic hazards of the area in which the farm is located, and which outlines a schedule of proposed changes in cropping systems and land use and of the conservation measures which are to be carried out on the

[13] This sentence was amended by the Agricultural Act of 1961, 75 Stat. 319.

farm or ranch during the contract period to protect the farm or ranch from erosion and deterioration by natural causes. Under the contract the producer shall agree—

(i) to effectuate the plan for his farm or ranch substantially in accordance with the schedule outlined therein unless any requirement thereof is waived or modified by the Secretary pursuant to paragraph (3) of this subsection;

(ii) to forfeit all rights to further payments or grants under the contract and refund to the United States all payments or grants received thereunder upon his violation of the contract at any stage during the time he has control of the farm if the Secretary determines that such violation is of such a nature as to warrant termination of the contract, or to make refunds or accept such payment adjustments as the Secretary may deem appropriate if he determines that the producer's violation does not warrant termination of the contract;

(iii) upon transfer of his right and interest in the farm or ranch during the contract period to forfeit all rights to further payments or grants under the contract and refund to the United States all payments or grants received thereunder unless the transferee of the farm or ranch agrees with the Secretary to assume all obligations of the contract;

(iv) not to adopt any practice specified by the Secretary in the contract as a practice which would tend to defeat the purposes of the contract;

(v) to such additional provisions as the Secretary determines are desirable and includes in the contract to effectuate the purposes of the program or to facilitate the practical administration of the program.

In return for such agreement by the producer the Secretary shall agree to share the cost of carrying out those conservation practices set forth in the contract for which he determines that cost-sharing is appropriate and in the public interest. The portion of such cost (including labor) to be shared shall be that part which the Secretary determines is necessary and appropriate to effecuate the physical installation of the conservation measures under the contract;

(2) the Secretary may terminate any contract with a producer by mutual agreement with the producer if the Secretary determines that such termination would be in the public interest, and may agree to such modification of contracts previously entered into as he may determine to be desirable to carry out the purposes of the program or facilitate the practical administration thereof;

(3)[14] insofar as the acreage of cropland on any farm enters into the determination of acreage allotments and marketing quotas under the Agricultural Adjustment Act of 1938, as amended, the cropland acreage on the farm shall not be decreased during the period of any contract heretofore or hereafter entered into under this subsection by reason of any action taken for the purpose of carrying out such contract and, under regulations of the Secretary, shall not be decreased, for such period after the expiration of the contract as is equal to the period of

[14] Subsecs. (3) and (4) were added by the Act of September 14, 1960, 74 Stat. 1030.

the contract, by reason of the maintenance of any change in land use from cultivated cropland to permanent vegetation carried out under the contract;

(4)[14] the acreage on any farm which is determined under regulations of the Secretary to have been diverted from the production of any commodity subject to acreage allotments or marketing quotas in order to carry out any contract heretofore or hereafter entered into under the program or in order to maintain, for such period after the expiration of the contract as is equal to the period of the contract, any change in land use from cultivated cropland to permanent vegetation carried out under the contract shall be considered acreage devoted to the commodity for the purposes of establishing future State, county, and farm acreage allotments under the Agricultural Adjustment Act of 1938, as amended.

(5) in applying the provisions of paragraph (6) of Public Law 74, Seventy-seventh Congress (7 U.S.C. 1340(6)), relating to the reduction of storage amount of wheat, any acreage diverted from the production of wheat under the program carried out under this subsection shall be regarded as wheat acreage;

(6) the Secretary shall utilize the technical services of agencies of the Department of Agriculture in determining the scope and provisions of any plan and the acceptability of the plan for effectuating the purposes of the program. In addition the Secretary shall take into consideration programs of State and local agencies, including soil conservation districts, having for their purposes the objectives of maximum soil and water conservation;

(7) there is hereby authorized to be appropriated without fiscal year limitations, such sums as may be necessary to carry out this subsection: *Provided*, That the total cost of the program (excluding administrative costs) shall not exceed $150,000,000, and for any program year payments shall not exceed $25,000,000. The funds made available for the program under this subsection may be expended without regard to the maximum payment limitation and small payment increases required under section 8(e) of this Act, and may be distributed among States without regard to distribution of funds formulas of section 15 of this Act. The program authorized under this subsection shall be in addition to, and not in substitution of, other programs in such area authorized by this or any other Act. (16 U.S.C. 590p(b).)

SEC. 16(c) (Applicable to Feed Grain Program for 1961. 75 Stat. 6, 16 U.S.C. 590p(c). See p. 124 of Agriculture Handbook 242 for text.)

SEC. 16(d) (Applicable to Feed Grain Program for 1962. 75 Stat. 302, 16 U.S.C. 590p(d). See p. 126 of Agriculture Handbook 242 for text.)

LAND USE ADJUSTMENT PROGRAM

SEC. 16(e)[15] (1) For the purpose of promoting the conservation and economic use of land, the Secretary, without regard to the foregoing

[14] Subsecs. (3) and (4) were added by the Act of September 14, 1960, 74 Stat. 1030.
[15] Sec. 16(e) was added by the Food and Agriculture Act of 1962, 76 Stat. 606, September 27, 1962.

provisions of this Act, except those relating to the use of the services of State and local committees, is authorized to enter into agreements, to be carried out during such period not to exceed ten years as he may determine, with farm and ranch owners and operators providing for changes in cropping systems and land uses and for practices or measures to be carried out primarily on any lands owned or operated by them and regularly used in the production of crops (including crops such as tame hay, alfalfa, and clovers, which do not require annual tillage, and including lands covered by conservation reserve contracts under subtitle B of the Soil Bank Act) for the purpose of conserving and developing soil, water, forest, wildlife, and recreation resources. Such agreements shall include such terms and conditions as the Secretary may deem desirable to effectuate the purposes of this subsection and may provide for payments, the furnishing of materials and services, and other assistance in amounts determined by the Secretary to be fair and reasonable, in consideration of the obligations undertaken by the farm and ranch owners and operators and the rights acquired by the Secretary: *Provided*, That agreements for the establishment of tree cover may not provide for annual payments with respect to such land for a period in excess of five years.

(2) No agreement shall be entered into under this subsection covering land with respect to which the ownership has changed in the two year period preceding the first year of the contract period unless (a) the new ownership was acquired by will or succession as a result of the death of the previous owner, (b) the land becomes a part of an existing farm or ranch, or (c) the land is combined with other land as a farming or ranching enterprise which the Secretary determines will effectuate the purposes of the program: *Provided*, That this provision shall not prohibit the continuation of an agreement by a new owner after an agreement has once been entered into under this subsection.

(3) The Secretary shall provide adequate safeguards to protect the interests of tenants and sharecroppers, including provision for sharing, on a fair and equitable basis, in payments under this subsection.

(4) The Secretary may agree to such modification of agreements previously entered into as he may determine to be desirable to carry out the purposes of this subsection or to facilitate the practical administration of the program carried out pursuant to this subsection.

(5) The Secretary shall issue such regulations as he determines necessary to carry out the provisions of this subsection.

(6) Notwithstanding any other provision of law, the Secretary, to the extent he deems it desirable to carry out the purposes of this subsection, may provide in any agreement hereunder for (A) preservation for a period not to exceed the period covered by the agreement and an equal period thereafter of the cropland, crop acreage, and allotment history applicable to land covered by the agreement for the purpose of any Federal program under which such history is used as a basis for an allotment or other limitation on the production of such crop; or (B) surrender of any such history and allotments.

(7) There is hereby authorized to be appropriated such sums as may be necessary to carry out this subsection. The Secretary is

authorized to utilize the facilities, services, authorities, and funds of the Commodity Credit Corporation in discharging his functions and responsibilities under this subsection including payment of costs of administration for the program authorized under this subsection: *Provided*, That after June 30, 1963, the Commodity Credit Corporation shall not make any expenditures for carrying out the purposes of this subsection unless the Corporation has received funds to cover such expenditures from appropriations made to carry out the purposes of this subsection. The Secretary shall not enter into agreements hereunder which would require payments, the furnishing of materials and services, and other assistance, in amounts in excess of $10,000,000 for any calendar year, except that the Secretary may enter into agreements hereunder with respect to lands previously covered by conservation reserve contracts which would require payments, the furnishing of materials and services, and other assistance, in an additional amount for the calendar year 1963 not exceeding $15,000,000. (16 U.S.C. 590p(e).)

DISBURSEMENTS TO PRODUCERS

SEC. 16. (f) [16] The Secretary is authorized to use the services, facilities, and authorities of Commodity Credit Corporation for the purpose of making disbursements to producers under programs formulated pursuant to sections 8 and 16(e) of this Act: *Provided*, That no such disbursements shall be made by Commodity Credit Corporation unless it has received funds to cover the amount thereof from appropriations available for the purpose of carrying out such programs. (16 U.S.C. 590p(f).)

SEC. 16. (g) (Applicable to the Feed Grain Program for 1963. 76 Stat. 607, 16 U.S.C. 590p(g). See p. 128 of Agriculture Handbook 242 for text.)

FEED GRAIN PROGRAM FOR 1964 AND 1965

SEC. 16. (h)[17] Notwithstanding any other provision of law—

(1) For the 1964 crop and the 1965 crop of feed grains, if the Secretary determines that the total supply of feed grains will, in the absence of an acreage diversion program, likely be excessive, taking into account the need for an adequate carryover to maintain reasonable and stable supplies and prices of feed grains and to meet any national emergency, he may formulate and carry out an acreage diversion program for feed grains, without regard to provisions which would be applicable to the regular agricultural conservation program, under which, subject to such terms and conditions as the Secretary determines, conservation payments in amounts determined by the Secretary to be fair and reasonable shall be made to producers who divert acreage from the production of feed grains to an approved conservation use and increase their average acreage of cropland devoted in 1959 and 1960 to designated soil-conserving crops or practices includ-

[16] Sec. 16(f) added by the Food and Agriculture Act of 1962, 76 Stat. 607, approved September 27, 1962.
[17] Sec. 16(h) added by Pub. L. 88–26, 77 Stat. 45, approved May 20, 1963.

ing summer fallow and idle land by an equal amount. Payments shall be not be made in amounts in excess of 50 per centum of the estimated basic county support rate, including that part of the support price made available through payments in kind, on the normal production of the acreage diverted from the commodity on the farm based on its adjusted average yield per acre. Notwithstanding the foregoing provisions, the Secretary may permit such diverted acreage to be devoted to the production of guar, sesame, safflower, sunflower, castor beans, mustard seed, and flax, if he determines that such crops are not in surplus supply and will not be in surplus supply if permitted to be grown on the diverted acreage, subject to the condition that payment with respect to diverted acreage devoted to any such crop shall be at a rate determined by the Secretary to be fair and reasonable, taking into consideration the use of such acreage for the production of such crops, but in no event shall the payment exceed one-half the rate which would otherwise be applicable if such acreage were devoted to conservation uses, and no price support shall be made available for the production of any such crop on such diverted acreage. The base period for the purpose of determining the adjusted average yield in the case of payments with respect to the 1964 crop shall be the four-year period 1959–1962, and in the case of payments with respect to the 1965 crop shall be the five-year period 1959–1963. The term "feed grains" means corn, grain sorghums, barley, and, if for any crop the producer so requests for purposes of having acreage devoted to the production of wheat considered as devoted to the production of feed grains, pursuant to the provisions of section 328 of the Food and Agriculture Act of 1962, the term "feed grains" shall include oats and rye: *Provided*, That acreages of corn, grain sorghums, and barley shall not be planted in lieu of acreages of oats and rye: *Provided further*, That the acreage devoted to the production of wheat shall not be considered as an acreage of feed grains for purposes of establishing the feed grain base acreage for the farm for subsequent crops. Such feed grain diversion program shall require the producer to take such measures as the Secretary may deem appropriate to keep such diverted acreage free from erosion, insects, weeds, and rodents. The acreage eligible for participation in the program shall be such acreage (not to exceed 50 per centum of the average acreage on the farm devoted to feed grains in the crop years 1959 and 1960 or twenty-five acres, whichever is greater) as the Secretary determines necessary to achieve the acreage reduction goal for the crop. Payments shall be made in kind. The average acreage of wheat produced on the farm during the crop years 1959, 1960, and 1961, pursuant to the exemption provided in section 335(f) of the Agricultural Adjustment Act of 1938, prior to its repeal by the Food and Agriculture Act of 1962, in excess of the small farm base acreage for wheat established under section 335 of the Agricultural Adjustment Act of 1938, as amended, shall be considered as an acreage of feed grains produced in the crop years of 1959 and 1960 for purposes of establishing the feed grain base acreage for the farm, and the rate

of payment for diverting such wheat shall be an amount determined by the Secretary to be fair and reasonable in relation to the rates of payment for diverting feed grains. The Secretary may make such adjustments in acreage and yields as he determines necessary to correct for abnormal factors affecting production, and to give due consideration to tillable acreage, crop-rotation practices, types of soil, soil and water conservation measures, and topography. To the extent that a producer proves the actual acreages and yields for the farm, such acreages and yields shall be used in making determinations. Notwithstanding any other provision of this subsection (*l*)(1),[18] the Secretary may, upon unanimous request of the State committee established pursuant to section 8(b) of the Soil Conservation and Domestic Allotment Act, as amended, adjust the feed grain bases for farms within any State or county to the extent he determines such adjustment to be necessary in order to establish fair and equitable feed grain bases for farms within such State or county. The Secretary may make not to exceed 50 per centum of any payments to producers in advance of determination of performance: *Provided*, That in no event shall the Secretary in the crop years 1964 or 1965 make payments to any producers under this section 16(h) and under section 105(d) of the Agricultural Act of 1949, as amended, in excess of 20 per centum of the fair market value of any acreage involved. Notwithstanding any other provision of this subsection (h)(1), barley shall not be included in the program for a producer of malting barley exempted pursuant to section 105(d) of the Agricultural Act of 1949 who participates only with respect to corn and grain sorghums and does not knowingly devote an acreage on the farm to barley in excess of 110 per centum of the average acreage devoted on the farm to barley in 1959 and 1960.

(2) Notwithstanding any other provision of this subsection, not to exceed 1 per centum of the estimated total feed grain bases for all farms in a State for any year may be reserved from the feed grain bases established for farms in the State for apportionment to farms on which there were no acreages devoted to feed grains in the crop years 1959 and 1960 on the basis of the following factors: Suitability of the land for the production of feed grains, the past experience of the farm operator in the production of feed grains, the extent to which the farm operator is dependent on income from farming for his livelihood, the production of feed grains on other farms owned, operated, or controlled by the farm operator, and such other factors as the Secretary determines should be considered for the purpose of establishing fair and equitable feed grain bases. An acreage equal to the feed grain base so established for each farm shall be deemed to have been devoted to feed grains on the farm in each of the crop years 1959 and 1960 for purposes of this subsection except that producers on such farm shall not be eligible for conservation payments for the first year for which the feed grain base is established.

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[18] Probably "(l)(1)" should be "(h)(1)."

(3) There are hereby authorized to be appropriated such amounts as may be necessary to enable the Secretary to carry out this section 16(h).

(4) The Secretary shall provide by regulations for the sharing of payments under this subsection among producers on the farm on a fair and equitable basis and in keeping with existing contracts.

(5) Payments in kind shall be made through the issuance of negotiable certificates which the Commodity Credit Corporation shall redeem for feed grains and, notwithstanding any other provision of law, the Commodity Credit Corporation shall, in accordance with regulations prescribed by the Secretary, assist the producer in the marketing of such certificates. In the case of any certificate not presented for redemption within thirty days of the date of its issuance, reasonable costs of storage and other carrying charges, as determined by the Secretary, for the period beginning thirty days after its issuance and ending with the date of its presentation for redemption shall be deducted from the value of the certificate. Feed grains with which Commodity Credit Corporation redeems certificates pursuant to this paragraph shall be valued at not less than the current support price, minus that part of the current support price made available through payments in kind, plus reasonable carrying charges.

(6) Notwithstanding any other provision of law, the Secretary may, by mutual agreement with the producer, terminate or modify any agreement previously entered into pursuant to this subsection if he determines such action necessary because of an emergency created by drought or other disaster, or in order to prevent or alleviate a shortage in the supply of feed grains. (16 U.S.C. 590 p(h).)

PAYMENT LIMITATIONS AS TO WETLANDS IN CERTAIN STATES

SEC. 16A.[19] The Secretary of Agriculture shall not enter into an agreement in the States of North Dakota, South Dakota, and Minnesota to provide financial or technical assistance for wetland drainage on a farm under authority of this Act, if the Secretary of the Interior has made a finding that wildlife preservation will be materially harmed on that farm by such drainage and that preservation of such land in its undrained status will materially contribute to wildlife preservation and such finding, identifying specifically the farm and the land on that farm with respect to which the finding was made, has been filed with the Secretary of Agriculture within ninety days after the filing of the application for drainage assistance: *Provided*, That the limitation against furnishing such financial or technical assistance shall terminate (1) at such time as the Secretary of the Interior notifies the Secretary of Agriculture that such limitation should not be applicable, (2) one year after the date on which the adverse finding of the Secretary of the Interior was filed unless during that time an offer has been made by the Secretary of the Interior or a State government agency to lease or to purchase the wetland area from the owner thereof

[19] Sec. 16A was added by the Act of October 2, 1962, 76 Stat. 696.

as a waterfowl resource, or (3) five years after the date on which such adverse finding was filed if such an offer to lease or to purchase such wetland area has not been accepted by the owner thereof: *Provided further*, That upon any change in the ownership of the land with respect to which such adverse finding was filed, the eligibility of such land for such financial or technical assistance shall be redetermined in accordance with the provisions of this section. (16 U.S.C. 590pA.)

SCOPE OF ACT; DEFINITION OF STATE

SEC. 17. (a) This Act shall apply to the States, the Commonwealth of Puerto Rico, and the Virgin Islands, and, as used in this Act, the term "State" includes Puerto Rico and the Virgin Islands. (16 U.S.C. 590q(a).)

(b) This Act may be cited as the "Soil Conservation and Domestic Allotment Act." (16 U.S.C. 590q(b).)

AGRICULTURAL ADJUSTMENT ACT OF 1938, AS AMENDED
EXPLANATORY NOTE

As enacted on February 16, 1938, this statute contained amendments which strengthened and broadened the Soil Conservation and Domestic Allotment Act, provided for assistance in the marketing of agricultural commodities for domestic consumption and export, provided for price support loans on wheat, corn, cotton and other agricultural commodities, authorized parity payments for corn, wheat, tobacco, cotton and rice, when funds were appropriated therefor, provided for farm marketing quotas for tobacco, corn, wheat, cotton and rice, and established the Federal Crop Insurance Corporation. The act has been amended many times since its enactment. In 1941, marketing quota and price support provisions for peanuts were added to the act and the marketing quota provisions for corn and wheat were changed in several important respects. In 1949, substantial changes were made in the marketing quota provisions for cotton and rice, and the price support provisions were repealed with the enactment of the Agricultural Act of 1949. The Agricultural Act of 1954 repealed the authority for marketing quotas for corn, but authority for corn acreage allotments was retained. Acreage allotments and a commercial corn-producing area were not established for the 1959 and subsequent crops of corn since a majority of the corn producers voting in the referendum held on November 25, 1958, favored a price support program without acreage allotments, as provided in section 104(b) of the Agricultural Act of 1949 (p. 151), as added by the Agricultural Act of 1958.

In 1961, Pub. L. 87–128, 75 Stat. 294, approved August 8, 1961, made numerous changes in the wheat provisions of the Act. Pub. L. 87–703, 76 Stat. 605, approved September 27, 1962 made further amendments in the wheat provisions of the Act effective with the 1964 and subsequent crops of wheat. A land use and a wheat marketing allocation program were also enacted by this law. Pub. L. 88–297, 78 Stat. 178, approved April 14, 1964, provided that a national marketing quota would not be in effect for the 1965 crop of wheat.

The constitutional validity of the marketing quota provisions has been upheld as to tobacco in the case *Mulford* v. *Smith* (307 U.S. 38), as to cotton in the case *Troppy* v. *LaSara Farmers Gin Co.* (113 F. 2d 350), as to wheat in the case *Wickard* v. *Filburn* (317 U.S. 111), and as to rice in the case of *Weir* v. *United States*, (310 F. 2d 149).

PART II

AGRICULTURAL ADJUSTMENT ACT OF 1938,[1] AS AMENDED

AN ACT

To provide for the conservation of national soil resources and to provide an adequate and balanced flow of agricultural commodities in interstate and foreign commerce and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Agricultural Adjustment Act of 1938." (7 U.S.C. 1281.)

DECLARATION OF POLICY

SEC. 2. It is hereby declared to be the policy of Congress to continue the Soil Conservation and Domestic Allotment Act, as amended, for the purpose of conserving national resources, preventing the wasteful use of soil fertility, and of preserving, maintaining, and rebuilding the farm and ranch land resources in the national public interest; to accomplish these purposes through the encouragement of soil-building and soil-conserving crops and practices; to assist in the marketing of agricultural commodities for domestic consumption and for export; and to regulate interstate and foreign commerce in cotton, wheat, corn, tobacco, and rice to the extent necessary to provide an orderly, adequate, and balanced flow of such commodities in interstate and foreign commerce through storage of reserve supplies, loans, marketing quotas, assisting farmers to obtain, insofar as practicable, parity prices for such commodities and parity of income, and assisting consumers to obtain an adequate and steady supply of such commodities at fair prices. (7 U.S.C. 1282.)

TITLE I—AMENDMENTS TO SOIL CONSERVATION AND DOMESTIC ALLOTMENT ACT

This title contains amendments to the Soil Conservation and Domestic Allotment Act, as amended. Insofar as now applicable, these amendments are incorporated in Part I of this compilation.

TITLE II—ADJUSTMENT IN FREIGHT RATES, NEW USES AND MARKETS, AND DISPOSITION OF SURPLUSES

ADJUSTMENTS IN FREIGHT RATES FOR FARM PRODUCTS

SEC. 201. (a) The Secretary of Agriculture is authorized to make complaint to the Interstate Commerce Commission with respect to rates, charges, tariffs, and practices relating to the transportation of

[1] Pub. L. 430, 75th Cong., 52 Stat. 31, approved February 16, 1938.

farm products, and to prosecute the same before the Commission. Before hearing or disposing of any complaint (filed by any person other than the Secretary) with respect to rates, charges, tariffs, and practices relating to the transportation of farm products, the Commission shall cause the Secretary to be notified, and, upon application by the Secretary, shall permit the Secretary to appear and be heard. (7 U.S.C. 1291(a).)

(b) If such rate, charge, tariff, or practice complained of is one affecting the public interest, upon application by the Secretary, the Commission shall make the Secretary a party to the proceeding. In such case the Secretary shall have the rights of a party before the Commission and the rights of a party to invoke and pursue original and appellate judicial proceedings involving the Commission's determination. The liability of the Secretary in any such case shall extend only to liability for court costs. (7 U.S.C. 1291(b).)

(c) For the purposes of this section, the Interstate Commerce Commission is authorized to avail itself of the cooperation, records, services, and facilities of the Department of Agriculture. (7 U.S.C. 1291(c).)

(d) The Secretary is authorized to cooperate with and assist cooperative associations of farmers making complaint to the Interstate Commerce Commission with respect to rates, charges, tariffs, and practices relating to the transportation of farm products. (7 U.S.C. 1291(d).)

NEW USES AND NEW MARKETS FOR FARM COMMODITIES

SEC. 202. (a) The Secretary is hereby authorized and directed to establish, equip, and maintain four regional research laboratories, one in each major farm producing area, and, at such laboratories, to conduct researches into and to develop new scientific, chemical, and technical uses and new and extended markets and outlets for farm commodities and products and byproducts thereof. Such research and development shall be devoted primarily to those farm commodities in which there are regular or seasonal surpluses, and their products and byproducts. (7 U.S.C. 1292(a).)

(b) For the purposes of subsection (a), the Secretary is authorized to acquire land and interests therein, and to accept in the name of the United States donations of any property, real or personal, to any laboratory established pursuant to this section, and to utilize voluntary or uncompensated services at such laboratories. Donations to any one of such laboratories shall not be available for use by any other of such laboratories. (7 U.S.C. 1292(b).)

(c) In carrying out the purposes of subsection (a), the Secretary is authorized and directed to cooperate with other departments or agencies of the Federal Government, States, State agricultural experiment stations, and other State agencies and institutions, counties, municipalities, business or other organizations, corporations, associations, universities, scientific societies, and individuals, upon such terms and conditions as he may prescribe. (7 U.S.C. 1292(c).)

(d) To carry out the purposes of subsection (a), the Secretary is authorized to utilize in each fiscal year, beginning with the fiscal year beginning July 1, 1938, a sum not to exceed $4,000,000 of the funds

appropriated pursuant to section 391 of this Act, or section 15 of the Soil Conservation and Domestic Allotment Act, as amended, for such fiscal year. The Secretary shall allocate one-fourth of such sum annually to each of the four laboratories established pursuant to this section. (7 U.S.C. 1292(d).)

(e)[2] * * *

(f) There is hereby allocated to the Secretary of Commerce for each fiscal year, beginning with the fiscal year beginning July 1, 1938, out of funds appropriated for such fiscal year pursuant to section 391 of this Act, or section 15 of the Soil Conservation and Domestic Allotment Act, as amended, the sum of $1,000,000 to be expended for the promotion of the sale of farm commodities and products thereof in such manner as he shall direct. Of the sum allocated under this subsection to the Secretary of Commerce for the fiscal year beginning July 1, 1938, $100,000 shall be devoted to making a survey and investigation of the cause or causes of the reduction in exports of agricultural commodities from the United States, in order to ascertain methods by which the sales in foreign countries of basic agricultural commodities produced in the United States may be increased. (7 U.S.C. 1292(f).)

(g) It shall be the duty of the Secretary to use available funds to stimulate and widen the use of all farm commodities in the United States and to increase in every practical way the flow of such commodities and the products thereof into the markets of the world. (7 U.S.C. 1292(g).)

TITLE III—LOANS, PARITY PAYMENTS, CONSUMER SAFEGUARDS, MARKETING QUOTAS, AND MARKETING CERTIFICATES

Subtitle A—Definitions, Parity Payments, and Consumer Safeguards

DEFINITIONS

SEC. 301. (a) GENERAL DEFINITIONS.—For the purposes of this title and the declaration of policy—

(1) (A) The "parity price" for any agricultural commodity, as of any date, shall be determined by multiplying the adjusted base price of such commodity as of such date by the parity index as of such date.

(B) The "adjusted base price" of any agricultural commodity, as of any date, shall be (i) the average of the prices received by farmers for such commodity, at such time as the Secretary may select during each year of the ten-year period ending on the 31st of December last before such date, or during each marketing season beginning in such period if the Secretary determines use of a calendar year basis to be impracticable, divided by (ii) the ratio of the general level of prices received by farmers for agricultural commodities during such period to the general level of prices received by farmers for agricultural commodities during the period

[2] Sec. 202(e) repealed by Pub. L. 706, 83d Cong., 68 Stat. 966, approved August 30, 1954.

January 1910 to December 1914, inclusive. As used in this subparagraph, the term "prices" shall include wartime subsidy payments made to producers under programs designed to maintain maximum prices established under the Emergency Price Control Act of 1942.

(C) The "parity index", as of any date, shall be the ratio of (i) the general level of prices for articles and services that farmers buy, wages paid hired farm labor, interest on farm indebtedness secured by farm real estate, and taxes on farm real estate, for the calendar month ending last before such date to (ii) the general level of such prices, wages, rates, and taxes during the period January 1910 to December 1914, inclusive.

(D) The prices and indices provided for herein, and the data used in computing them, shall be determined by the Secretary, whose determination shall be final.

(E) Notwithstanding the provisions of subparagraph (A), the transitional parity price for any agricultural commodity, computed as provided in this subparagraph, shall be used as the parity price for such commodity until such date after January 1, 1950, as such transitional parity price may be lower than the parity price, computed as provided in subparagraph (A), for such commodity. The transitional parity price for any agricultural commodity as of any date shall be—

(i) its parity price determined in the manner used prior to the effective date of the Agricultural Act of 1948, less

(ii) 5 per centum of the parity price so determined, multiplied by the number of full calendar years (not counting 1956 in the case of basic agricultural commodities) which, as of such date, have elapsed after January 1, 1949, in the case of nonbasic agricultural commodities, and after January 1, 1955, in the case of the basic agricultural commodities.

(F) Notwithstanding the provisions of subparagraphs (A) and (E), if the parity price for any agricultural commodity, computed as provided in subparagraphs (A) and (E) appears to be seriously out of line with the parity prices of other agricultural commodities, the Secretary may, and upon the request of a substantial number of interested producers shall, hold public hearings to determine the proper relationship between the parity price of such commodity and the parity prices of other agricultural commodities. Within sixty days after commencing such hearing the Secretary shall complete such hearing, proclaim his findings as to whether the facts require a revision of the method of computing the parity price of such commodity, and put into effect any revision so found to be required.

(G) Notwithstanding the foregoing provisions of this section, the parity price for any basic agricultural commodity, as of any date during the six-year period beginning January 1, 1950, shall not be less than its parity price computed in the manner used prior to the enactment of the Agricultural Act of 1949.

[Prior to enactment of the Agricultural Acts of 1948 and 1949, the term "parity" was defined in sec. 301(a) of the Agricultural Adjustment Act of 1938, as amended, as follows: " 'Parity', as applied to

prices for any agricultural commodity, shall be that price for the commodity which will give to the commodity a purchasing power with respect to articles that farmers buy equivalent to the purchasing power of such commodity in the base period; and, in the case of all commodities for which the base period is the period August 1909 to July 1914, which will also reflect current interest payments per acre on farm indebtedness secured by real estate, tax payments per acre on farm real estate, and freight rates, as contrasted with such interest payments, tax payments, and freight rates during the base period. The base period in case of all agricultural commodities except tobacco shall be the period August 1909 to July 1914. In the case of all kinds of tobacco except Burley and flue-cured such base period shall be the period August 1919 to July 1929, and, in the cause of Burley and flue-cured tobacco, shall be the period August 1934 to July 1939; except that the August 1919–July 1929 base period shall be used in allocating any funds appropriated prior to September 1, 1940."[3] (52 Stat. 38, 54 Stat. 1210.)]

(2) "Parity", as applied to income, shall be that gross income from agriculture which will provide the farm operator and his family with a standard of living equivalent to those afforded persons dependent upon other gainful occupations. "Parity" as applied to income from any agricultural commodity for any year, shall be that gross income which bears the same relationship to parity income from agriculture for such year as the average gross income from such commodity for the preceding ten calendar years bears to the average gross income from agriculture for such ten calendar years.

(3) The term "interstate and foreign commerce" means sale, marketing, trade, and traffic between any State or Territory or the District of Columbia or Puerto Rico, and any place outside thereof; or between points within the same State or Territory or within the District of Columbia or Puerto Rico, through any place outside thereof; or within any Territory or within the District of Columbia or Puerto Rico.

(4) The term "affect interstate and foreign commerce" means, among other things, in such commerce, or to burden or obstruct such commerce or the free and orderly flow thereof; or to create or tend to create a surplus of any agricultural commodity which burdens or obstructs such commerce or the free and orderly flow thereof.

(5) The term "United States" means the several States and Territories and the District of Columbia and Puerto Rico.

(6) The term "State" includes a Territory and the District of Columbia and Puerto Rico.

(7) The term "Secretary" means the Secretary of Agriculture, and the term "Department" means the Department of Agriculture.

(8) The term "person" means an individual, partnership, firm, joint-stock company, corporation, association, trust, estate, or any agency of a State.

(9) The term "corn" means field corn. (7 U.S.C. 1301(a).)

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[3] For Maryland tobacco the base period is August 1936 to July 1941 (Pub. L. 897, 80th Cong., 62 Stat. 1248, approved July 3, 1948).

[Agricultural Act of 1948.[4] SEC. 302(f). All references in other laws to—

(1) parity,
(2) parity prices,
(3) prices comparable to parity prices, or
(4) prices to be determined in the same manner as provided by the Agricultural Adjustment Act of 1938 prior to its amendment by this Act for the determination of parity prices,

with respect to prices for agricultural commodities and products thereof, shall hereafter be deemed to refer to parity prices as determined in accordance with the provisions of section 301(a)(1) of the Agricultural Adjustment Act of 1938, as amended by this Act. (7 U.S.C. 1301a.)]

(b) DEFINITIONS APPLICABLE TO ONE OR MORE COMMODITIES.—For the purposes of this title—

(1) (A) "Actual production" as applied to any acreage of corn means the number of bushels of corn which the local committee determines would be harvested as grain from such acreage if all the corn on such acreage were so harvested. In case of a disagreement between the farmer and the local committee as to the actual production of the acreage of corn on the farm, or in case the local committee determines that such actual production is substantially below normal, the local committee, in accordance with regulations of the Secretary, shall weigh representative samples of ear corn taken from the acreage involved, make proper deductions for moisture content, and determine the actual production of such acreage on the basis of such samples.

(B) "Actual production" of any number of acres of cotton, rice or peanuts on a farm means the actual average yield for the farm times such number of acres.

(2) "Bushel" means in the case of ear corn that amount of ear corn, including not to exceed 15½ per centum of moisture content, which weighs seventy pounds, and in the case of shelled corn, means that amount of shelled corn including not to exceed 15½ per centum of moisture content, which weighs fifty-six pounds.

(3) (A) "Carry-over," in the case of corn, rice, and peanuts for any marketing year shall be the quantity of the commodity on hand in the United States at the beginning of such marketing year, not including any quantity which was produced in the United States during the calendar year then current.

(B) "Carry-over" of cotton for any marketing year shall be the quantity of cotton on hand in the United States at the beginning of such marketing year, not including any part of the crop which was produced in the United States during the calendar year then current.

[NOTE.—As originally enacted this term included domestically produced cotton on hand within or without the United States. A new definition, excluding American cotton on hand outside the United States, was enacted in Sec. 201(c) of the Agricultural Act of 1948 (62 Stat. 1250). The definition was changed again by Sec. 2(a) of Pub. L. 272, 81st Cong., approved August 29, 1949 (63 Stat. 675), to include all cotton on hand in the United States whether produced within or with-

[4] Pub. L. 897, 80th Cong., 62 Stat. 1258, approved July 3, 1948.

out the United States. Sec. 415(e) of the Agricultural Act of 1949 (63 Stat. 1056) repealed Sec. 201(c) of the Agricultural Act of 1948. Therefore, the provision now in effect is the definition appearing herein which is the definition enacted by Pub. L. 272, 81st Cong.]

(C) "Carry-over" of tobacco for any marketing year shall be the quantity of such tobacco on hand in the United States at the beginning of such marketing year (or on January 1 of such marketing year in the case of Maryland tobacco), which was produced in the United States prior to the beginning of the calendar year in which such marketing year begins, except that in the case of cigar-filler and cigar-binder tobacco the quantity of type 46 on hand and theretofore produced in the United States during such calendar year shall also be included.

(D) "Carry-over" of wheat, for any marketing year shall be the quantity of wheat on hand in the United States at the beginning of such marketing year, not including any wheat which was produced in the United States during the calendar year then current, and not including any wheat held by the Federal Crop Insurance Corporation under Title V [of the Agricultural Adjustment Act of 1938].

(4) (A) "Commercial corn-producing area" shall include all counties in which the average production of corn (excluding corn used as silage) during the ten calendar years immediately preceding the calendar year for which such area is determined, after adjustment for abnormal weather conditions, is four hundred and fifty bushels or more per farm and four bushels or more for each acre of farm land in the county.

(B) Whenever prior to February 1 of any calendar year the Secretary has reason to believe that any county which is not included in the commercial corn-producing area determined pursuant to the provisions of subparagraph (A), but which borders upon one of the counties in such area, or that any minor civil division in a county bordering on such area, is producing (excluding corn used for silage) an average of at least four hundred and fifty bushels of corn per farm and an average of at least four bushels for each acre of farm land in the county or in the minor civil division, as the case may be, he shall cause immediate investigation to be made to determine such fact. If, upon the basis of such investigation, the Secretary finds that such county or minor civil division is likely to produce corn in such average amounts during such calendar year, he shall proclaim such determination, and commencing with such calendar year, such county shall be included in the commercial corn-producing area. In the case of a county included in the commercial corn-producing area pursuant to this subparagraph, whenever prior to February 1 of any calendar year the Secretary has reason to believe that facts justifying the inclusion of such county are not likely to exist in such calendar year, he shall cause an immediate investigation to be made with respect thereto. If, upon the basis of such investigation, the Secretary finds that such facts are not likely to exist in such calendar year, he shall proclaim such determination, and commencing with such calendar year, such county shall be excluded from the commercial corn-producing area.

(5) "Farm consumption" of corn means consumption by the farmer's family, employees, or household, or by his work stock; or consumption by poultry or livestock on his farm if such poultry or livestock, or the products thereof, are consumed or to be consumed by the farmer's family, employees, or household.

(6) (A) "Market", in the case of corn, cotton, rice, tobacco, and wheat, means to dispose of, in raw or processed form, by voluntary or involuntary sale, barter, or exchange, or by gift inter vivos, and, in the case of corn and wheat, by feeding (in any form) to poultry or livestock which, or the products of which, are sold, bartered, or exchanged, or to be so disposed of, but does not include disposing of any of such commodities as premium to the Federal Crop Insurance Corporation under Title V [of the Agricultural Adjustment Act of 1938].

(B) "Marketed", "marketing", and "for market" shall have corresponding meanings to the term "market" in the connection in which they are used.

(C) "Market", in the case of peanuts, means to dispose of peanuts, including farmers' stock peanuts, shelled peanuts, cleaned peanuts, or peanuts in processed form, by voluntary or involuntary sale, barter, or exchange, or by gift inter vivos.

(7) "Marketing year" means, in the case of the following commodities, the period beginning on the first and ending with the second date specified below:

Corn, October 1–September 30;
Cotton, August 1–July 31;
Rice, August 1–July 31;
Tobacco (flue-cured), July 1–June 30;
Tobacco (other than flue-cured), October 1–September 30;
Wheat, July 1–June 30.
[Peanuts, August 1–July 31 (see Sec. 359(a)) page 93.]

(8) "National average yield" as applied to cotton or wheat shall be the national average yield per acre of the commodity during the ten calendar years in the case of wheat, and during the five calendar years in the case of cotton, preceding the year in which such national average yield is used in any computation authorized in this title, adjusted for abnormal weather conditions and, in the case of wheat, but not in the case of cotton, for trends in yields.

(9) "Normal production" as applied to any number of acres of corn, cotton, rice, or wheat means the normal yield for the farm times such number of acres.

(10) (A) "Normal supply" in the case of corn, rice, wheat, and peanuts for any marketing year shall be (i) the estimated domestic consumption of the commodity for the marketing year ending immediately prior to the marketing year for which normal supply is being determined, plus (ii) the estimated exports of the commodity for the marketing year for which normal supply is being determined, plus (iii) an alowance for carry-over. The allowance for carry-over shall be the following percentage of the sum of the consumption and exports used in computing normal supply: 15 per centum in the case of corn; 10 per centum in the case of rice; 20 per centum in the case of wheat; and 15

per centum in the case of peanuts. In determining normal supply the Secretary shall make such adjustments for current trends in consumption and for unusual conditions as he may deem necessary.

[NOTE.—Sec. 2(a)(2) of the Act of Aug. 29, 1949 (63 Stat. 676), deleted "cotton" from the foregoing definition and added a new subparagraph (C) containing the definition of "normal supply" of cotton. The word "cotton" has not been omitted in the first sentence of sec. 1301(b)(10)(A) of title 7 of the U.S. Code. 1958 Ed.]

(B) "Normal supply" in the case of tobacco shall be a normal year's domestic consumption and exports, plus 175 per centum of a normal year's domestic consumption and 65 per centum of a normal year's exports as an allowance for a normal carry-over.

(C) The "normal supply" of cotton for any marketing year shall be the estimated domestic consumption of cotton for the marketing year for which such normal supply is being determined, plus the estimated exports of cotton for such marketing year, plus 30 per centum of the sum of such consumption and exports as an allowance for carry-over.

(11) (A) "Normal year's domestic consumption", in the case of corn and wheat, shall be the yearly average quantity of the commodity, wherever produced, that was consumed in the United States during the ten marketing years immediately preceding the marketing year in which such consumption is determined, adjusted for current trends in such consumption.

(B) "Normal year's domestic consumption", in the case of cotton and tobacco, shall be the yearly average quantity of the commodity produced in the United States that was consumed in the United States during the ten marketing years immediately preceding the marketing year in which such consumption is determined, adjusted for current trends in such consumption.

(C) "Normal year's domestic consumption", in the case of rice, shall be the yearly average quantity of rice produced in the United States that was consumed in the United States during the five marketing years immediately preceding the marketing year in which such consumption is determined, adjusted for current trends in such consumption.

(12) "Normal year's exports" in the case of corn, cotton, rice, tobacco, and wheat shall be the yearly average quantity of the commodity produced in the United States that was exported from the United States during the ten marketing years (or, in the case of rice, the five marketing years) immediately preceding the marketing year in which such exports are determined, adjusted for current trends in such exports.

(13) (A)[5] * * *

(B) [6] "Normal yield" for any county, in the case of peanuts, shall be the average yield per acre of peanuts for the county, adjusted for abnormal weather conditions, during the five calendar years immediately preceding the year in which such normal yield is determined.

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[5] Repealed by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962.
[6] The words, "cotton or" appearing before the word "peanuts" were deleted by Pub. L. 88–297, 78 Stat. 177, approved April 11, 1964.

(C) In applying subparagraph (A) or (B), if for any such year the data are not available, or there is no actual yield, an appraised yield for such year, determined in accordance with regulations issued by the Secretary, shall be used as the actual yield for such year. In applying such subparagraphs, if, on account of drought, flood, insect pests, plant disease, or other uncontrollable natural cause, the yield in any year of such ten-year period or five-year period, as the case may be, is less than 75 per centum of the average (computed without regard to such year) such year shall be eliminated in calculating the normal yield per acre.

(D) [7] "Normal yield" for any county, in the case of rice and wheat, shall be the average yield per acre of rice or wheat, as the case may be, for the county during the five calendar years immediately preceding the year for which such normal yield is determined in the case of rice, or during the five years immediately preceding the year in which such normal yield is determined in the case of wheat, adjusted for abnormal weather conditions and for trends in yields. If for any such year data are not available, or there is no actual yield, an appraised yield for such year, determined in accordance with regulations issued by the Secretary, taking into consideration the yields obtained in surrounding counties during such year and the yield in years for which data are available, shall be used as the actual yield for such year.

(E) [8] "Normal yield" for any farm, in the case of rice and wheat, shall be the average yield per acre of rice or wheat, as the case may be, for the farm during the five calendar years immediately preceding the year for which such normal yield is determined in the case of rice, or during the five years immediately preceding the year in which such normal yield is determined in the case of wheat, adjusted for abnormal weather conditions and for trends in yields. If for any such year the data are not available or there is no actual yield, then the normal yield for the farm shall be appraised in accordance with regulations issued by the Secretary, taking into consideration abnormal weather conditions, trends in yields, the normal yield for the county, the yields obtained on adjacent farms during such year and the yield in years for which data are available.

(F) In applying subparagraphs (D) and (E), if on account of drought, flood, insect pests, plant disease, or other uncontrollable natural cause, the yield for any year of such five-year period is less than 75 per centum of the average, 75 per centum of such average shall be substituted therefor in calculating the normal yield per acre. If, on account of abnormally favorable weather conditions, the yield for any year of such five-year period is in excess of 125 per centum of the average, 125 per centum of such average shall be substituted therefor in calculating the normal yield per acre.

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[7] The words, "and wheat," "or wheat, as the case may be," and "in the case of rice, or during the five years immediately preceding the year in which such normal yield is determined in the case of wheat," were added by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962.

[8] The words, "and wheat," "or wheat, as the case may be," and "in the case of rice, or during the five years immediately preceding the year in which such normal yield is determined in the case of wheat," were added by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962.

(G) [9] "Normal yield" for any farm, in the case of corn or peanuts, shall be the average yield per acre of corn or peanuts, as the case may be, for the farm, adjusted for abnormal weather conditions during the five calendar years immediately preceding the year in which such normal yield is determined. If for any such year the data are not available or there is no actual yield, then the normal yield for the farm shall be appraised in accordance with regulations of the Secretary, taking into consideration abnormal weather conditions, the normal yield for the county, and the yield in years for which data are available.

(H) [10] "Normal yield" for any county, for any crop of cotton, shall be the average yield per acre of cotton for the county, adjusted for abnormal weather conditions and any significant changes in production practices during the five calendar years immediately preceding the year in which the national marketing quota for such crop is proclaimed. If for any such year the data are not available, or there is no actual yield, an appraised yield for such year, determined in accordance with regulations issued by the Secretary, shall be used as the actual yield for such year.

(I) [11] "Normal yield" for any farm, for any crop of cotton, shall be the average yield per acre of cotton for the farm, adjusted for abnormal weather conditions and any significant changes in production practices during the three calendar years immediately preceding the year in which such normal yield is determined. If for any such year the data are not avaliable, or there is no actual yield, then the normal yield for the farm shall be appraised in accordance with regulations of the Secretary, taking into consideration abnormal weather conditions, the normal yield for the county, changes in production practices, and the yield in years for which data are available.

(14) (A) "Reserve supply level", in the case of corn, shall be a normal year's domestic consumption and exports of corn plus 10 per centum of a normal year's domestic consumption and exports, to insure a supply adequate to meet domestic consumption and export needs in years of drought, flood, or other adverse conditions, as well as in years of plenty.

(B) "Reserve supply level" of tobacco shall be the normal supply plus 5 per centum thereof, to insure a supply adequate to meet domestic consumption and export needs in years of drought, flood, or other adverse conditions, as well as in years of plenty.

(15) "Tobacco" means each one of the kinds of tobacco listed below comprising the types specified as classified in Service and Regulatory Announcement Numbered 118 of the Bureau of Agricultural Economics of the Department:

Flue-cured tobacco, comprising types 11, 12, 13, and 14;
Fire-cured tobacco, comprising types 21, 22, 23, and 24;
Dark air-cured tobacco, comprising types 35 and 36;
Virginia sun-cured tobacco, comprising type 37;

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[9] The word, "cotton," deleted by Pub. L. 88–297, 78 Stat. 177, approved April 11, 1964.
[10] A new subsection (H) was added by Pub. L. 88–297, 78 Stat. 177, approved April 11, 1964.
[11] A new subsection (I) was added by Pub. L. 88–297, 78 Stat. 177, approved April 11, 1964.

Burley tobacco, comprising type 31;
Maryland tobacco, comprising type 32;
Cigar-filler and cigar-binder tobacco, comprising types 42, 43, 44, 45, 46, 51, 52, 53, 54, and 55;
Cigar-filler tobacco, comprising type 41.

The provisions of this title shall apply to each of such kinds of tobacco severally: *Provided*, That any one or more of the types comprising any such kind of tobacco shall be treated as a "kind of tobacco" for the purposes of this Act if the Secretary finds there is a difference in supply and demand conditions as among such types of tobacco which results in a difference in the adjustments needed in the marketings thereof in order to maintain supplies in line with demand: *Provided further*, That with respect to the 1958 and subsequent crops, type 21 (Virginia) fire-cured tobacco shall be treated as a "kind of tobacco" for the purposes of all of the provisions of this title, except that for the purposes of section 312(c) of this title, types 21, 22, and 23, fire-cured tobacco shall be treated as one "kind of tobacco".[12]

(16) (A) "Total supply" of wheat, corn, rice, and peanuts for any marketing year shall be the carry-over of the commodity for such marketing year, plus the estimated production of the commodity in the United States during the calendar year in which such marketing year begins and the estimated imports of the commodity into the United States during such marketing year.

(B) "Total supply" of tobacco for any marketing year shall be the carry-over at the beginning of such marketing year (or on January 1 of such marketing year in the case of Maryland tobacco) plus the estimated production thereof in the United States during the calendar year in which such marketing year begins, except that the estimated production of type-46 tobacco during the marketing year with respect to which the determination is being made shall be used in lieu of the estimated production of such type during the calendar year in which such marketing year begins in determining the total supply of cigar-filler and cigar-binder tobacco.

(C) "Total supply" of cotton for any marketing year shall be the carry-over at the beginning of such marketing year, plus the estimated production of cotton in the United States during the calendar year in which such marketing year begins and the estimated imports of cotton into the United States during such marketing year. (7 U.S.C. 1301(b).)

(c) The latest available statistics of the Federal Government shall be used by the Secretary in making the determinations required to be made by the Secretary under this Act. (7 U.S.C. 1301(c).)

(d) In making any determination under this Act or under the Agricultural Act of 1949 with respect to the carryover of any agricultural commodity, the Secretary shall exclude from such determination the stocks of any commodity acquired pursuant to, or under the authority of, the Strategic and Critical Materials Stock Piling Act (60 Stat. 596). (7 U.S.C. 1301(d).)

Sec. 302.[13] * * *

[12] This proviso was enacted by Pub. L. 85–92, 71 Stat. 284, approved July 10, 1957.
[13] Section 302 repealed by Pub. L. 439, 81st Cong., 63 Stat. 1057, approved October 31, 1949.

PARITY PAYMENTS

SEC. 303. If and when appropriations are made therefor, the Secretary is authorized and directed to make payments to producers of corn, wheat, cotton, rice, or tobacco, on their normal production of such commodities in amounts which, together with the proceeds thereof, will provide a return to such producers which is as nearly equal to parity price as the funds so made available will permit. All funds available for such payments with respect to these commodities shall, unless otherwise provided by law, be apportioned to these commodities in proportion to the amount by which each fails to reach the parity income. Such payments shall be in addition to and not in substitution for any other payments authorized by law. (7 U.S.C. 1303.)

CONSUMER SAFEGUARDS

SEC. 304. The powers conferred under this Act shall not be used to discourage the production of supplies of foods and fibers sufficient to maintain normal domestic human consumption as determined by the Secretary from the records of domestic human consumption in the years 1920 to 1929, inclusive, taking into consideration increased population, quantities of any commodity that were forced into domestic consumption by decline in exports during such period, current trends in domestic consumption and exports of particular commodities, and the quantities of substitutes available for domestic consumption within any general class of food commodities. In carrying out the purposes of this Act it shall be the duty of the Secretary to give due regard to the maintenance of a continuous and stable supply of agricultural commodities from domestic production adequate to meet consumer demand at prices fair to both producers and consumers. (7 U.S.C. 1304.)

SUBTITLE B—MARKETING QUOTAS

PART I—MARKETING QUOTAS—TOBACCO

LEGISLATIVE FINDINGS

SEC. 311. (a) The marketing of tobacco constitutes one of the great basic industries of the United States with ramifying activities which directly affect interstate and foreign commerce at every point, and stable conditions therein are necessary to the general welfare. Tobacco produced for market is sold on a Nation-wide market and, with its products, moves almost wholly in interstate and foreign commerce from the producer to the ultimate consumer. The farmers producing such commodity are subject in their operations to uncontrollable natural causes, are widely scattered throughout the Nation, in many cases such farmers carry on their farming operations on borrowed money or leased lands, and are not so situated as to be able to organize effectively, as can labor and industry through unions and corporations enjoying Government protection and sanction. For these reasons, among others, the farmers are unable without Federal assistance to control effectively the orderly marketing of such commodity with the result that abnormally excessive supplies thereof are produced

and dumped indiscriminately on the Nation-wide market. (7 U.S.C. 1311(a).)

(b) The disorderly marketing of such abnormally excessive supplies affects, burdens, and obstructs interstate and foreign commerce by (1) materially affecting the volume of such commodity marketed therein, (2) disrupting the orderly marketing of such commodity therein, (3) reducing the price for such commodity with consequent injury and destruction of interstate and foreign commerce in such commodity, and (4) causing a disparity between the prices for such commodity in interstate and foreign commerce and industrial products therein, with a consequent diminution of the volume of interstate and foreign commerce in industrial products. (7 U.S.C. 1311(b).)

(c) Whenever an abnormally excessive supply of tobacco exists, the marketing of such commodity by the producers thereof directly and substantially affects interstate and foreign commerce in such commodity and its products, and the operation of the provisions of this part becomes necessary and appropriate in order to promote, foster, and maintain an orderly flow of such supply in interstate and foreign commerce. (7 U.S.C. 1311 (c).)

NATIONAL MARKETING QUOTA

SEC. 312. (a) The Secretary shall, not later than December 1 of any marketing year with respect to flue-cured tobacco, and February 1 of any marketing year with respect to other kinds of tobacco, proclaim a national marketing quota for any kind of tobacco for each of the next three succeeding marketing years whenever he determines with respect to such kind of tobacco—

(1) that a national marketing quota has not previously been proclaimed and the total supply as of the beginning of such marketing year exceeds the reserve supply level therefor;

(2) that such marketing year is the last year of three consecutive years for which marketing quotas previously proclaimed will be in effect;

(3) that amendments have been made in provisions for establishing farm acreage allotments which will cause material revision of such allotments before the end of the period for which quotas are in effect; or

(4) that a marketing quota previously proclaimed for such marketing year is not in effect because of disapproval by producers in a referendum held pursuant to subsection (c) : *Provided*, That if such producers have disapproved national marketing quotas in referenda held in three successive years subsequent to 1952, thereafter a national marketing quota shall not be proclaimed hereunder which would be in effect for any marketing year within the three-year period for which national marketing quotas previously proclaimed were disapproved by producers in a referendum, unless prior to November 10 of the marketing year one-fourth or more of the farmers engaged in the production of the crop of tobacco harvested in the calendar year in which such marketing year begins petition the Secretary, in accordance with such regulations as he may prescribe, to proclaim a national mar-

keting quota for each of the next three succeeding marketing years. (7 U.S.C. 1312(a).)

(b) The Secretary shall also determine and announce not later than the first day of December with respect to flue-cured tobacco and not later than the first day of February with respect to other kinds of tobacco, the amount of the national marketing quota proclaimed pursuant to subsection (a) which is in effect for the next marketing year in terms of the total quantity of tobacco which may be marketed which will make available during such marketing year a supply of tobacco equal to the reserve supply level. The amount of the national marketing quota so announced may, not later than the following March 1, be increased by not more than 20 per centum if the Secretary determines that such increase is necessary in order to meet market demands or to avoid undue restrictions of marketings in adjusting the total supply to the reserve supply level. (7 U.S.C. 1312(b).)

(c) Within thirty days after the proclamation of national marketing quotas under subsection (a), the Secretary shall conduct a referendum of farmers engaged in the production of the crop of tobacco harvested immediately prior to the holding of the referendum to determine whether such farmers are in favor of or opposed to such quotas for the next three succeeding marketing years. If more than one-third of the farmers voting oppose the national marketing quotas, such results shall be proclaimed by the Secretary and the national marketing quotas so proclaimed shall not be in effect but such results shall in no wise affect or limit the subsequent proclamation and submission to a referendum, as otherwise provided in this section, of a national marketing quota. (7 U.S.C. 1312(c).)

APPORTIONMENT OF NATIONAL MARKETING QUOTA

SEC. 313. (a) The national marketing quota for tobacco established pursuant to the provisions of section 312, less the amount to be allotted under subsection (c) of this section, shall be apportioned by the Secretary among the several States on the basis of the total production of tobacco in each State during the five calendar years immediately preceding the calendar year in which the quota is proclaimed (plus in applicable years, the normal production on the acreage diverted under previous agricultural adjustment and conservation programs), with such adjustments as are determined to be necessary to make correction for abnormal conditions of production, for small farms, and for trends in production, giving due consideration to seed bed and other plant diseases during such five-year period. Notwithstanding any other provision of this section and section 312 * * * the burley tobacco acreage allotment which would otherwise be established for any farm having a burley acreage allotment in 1942 shall not be less than one-half acre, and the acreage required for apportionment under this proviso shall be in addition to the National and State acreage allotments. (7 U.S.C. 1313(a).)

[Act of July 12, 1952.[14] * * * notwithstanding any other provision of law, effective for the 1956 and subsequent crops of burley tobacco,

[14] Pub. L. 528, 82d Cong., 66 Stat. 597, amended further by Pub. L. 21, 84th Cong., 69 Stat. 24, approved March 31, 1955.

the farm acreage allotment for burley tobacco for any year shall not be less than the smallest of (1) the allotment established for the farm for the immediately preceding year, (2) five-tenths of an acre, or (3) 10 per centum of the cropland: *Provided*, *however*, That no allotment of seven-tenths of an acre or less shall be reduced more than one-tenth of an acre in any one year. The additional acreage required under this Act shall be in addition to the State acreage allotments and the production on such acreage shall be in addition to the national marketing quota. (7 U.S.C. 1315.)]

(b) The Secrtary shall provide, through the local committees, for the allotment of the marketing quota for any State among the farms on which tobacco is produced, on the basis of the following: Past marketing of tobacco, making due allowance for drought, flood, hail, other abnormal weather conditions, plant bed, and other diseases; land, labor, and equipment available for the production of tobacco; crop-rotation practices; and the soil and other physical factors affecting the production of tobacco: *Provided*, That, except for farms on which for the first time in five years tobacco is produced to be marketed in the marketing year for which the quota is effective, the marketing quota for any farm shall not be less than the smaller of either (1) three thousand two hundred pounds, in the case of flue-cured tobacco, and two thousand four hundred pounds, in the case of other kinds of tobacco, or (2) the average tobacco production for the farm during the preceding three years, plus the average normal productior of any tobacco acreage diverted under agricultural adjustment and conservation programs during such preceding three years. (7 U.S.C. 1313(b).)

(c) The Secretary shall provide, through local committees, for the allotment of not in excess of 5 per centum of the national marketing quota (1) to farms in any State whether it has a State quota or not on which for the first time in five years tobacco is produced to be marketed in the year for which the quota is effective and (2) for further increase of allotments to small farms pursuant to the proviso in subsection (b) of this section on the basis of the following: Land, labor, and equipment available for the production of tobacco; crop-rotation practices; and the soil and other physical factors affecting the production of tobacco: *Provided*, That farm marketing quotas established pursuant to this subsection for farms on which tobacco is produced for the first time in five years shall not exceed 75 per centum of the farm marketing quotas established pursuant to subsection (b) of this section for farms which are similar with respect to the following: Land, labor, and equipment available for the production of tobacco, crop-rotation practices, and the soil and other physical factors affecting the production of tobacco. (7 U.S.C. 1313(c).)

(d) Farm marketing quotas may be transferred only in such manner and subject to such conditions as the Secretary may prescribe by regulations. (7 U.S.C. 1313(d).)

(e) In case of flue-cured tobacco, the national quota for 1938 is increased by a number of pounds required to provide for each State in addition to the State poundage allotment a poundage not in excess of 4 per centum of the allotment which shall be apportioned in amounts which the Secretary determines to be fair and reasonable to farms in

the State receiving allotments under the Agricultural Adjustment Act of 1938 which the Secretary determines are inadequate in view of past production of tobacco, and for each year by a number of pounds sufficient to assure that any State receiving a State poundage allotment of flue-cured tobacco shall receive a minimum State poundage allotment of flue-cured tobacco equal to the average national yield for the preceding five years of five hundred acres of such tobacco. (7 U.S.C. 1313(e).)

(f) (Applicable only to 1938 crop.)

(g) Notwithstanding any other provision of this section, the Secretary on the basis of average yield per acre of tobacco for the State during the five years last preceding the year in which the national marketing quota is proclaimed, adjusted for abnormal conditions of production, may convert the State marketing quota into a State acreage allotment, and allot the same through the local committees among farms on the basis of the factors set forth in subsection (b), using past acreage (harvested and diverted) in lieu of the past marketing of tobacco; and the Secretary on the basis of the national average yield during the same period, similarly adjusted, may also convert into an acreage allotment the amount reserved from the national quota pursuant to the provisions of subsection (c), and on the basis of the factors set forth in subsection (c) and the past tobacco experience of the farm operator, allot the same through the local committees among farms on which no tobacco was produced during the last five years. Any acreage of tobacco harvested in excess of the farm acreage allotment for the year 1955, or any subsequent crop shall not be taken into account in establishing State and farm acreage allotments. Except for farms last mentioned or a farm operated, controlled, or directed by a person who also operates, controls, or directs another farm on which tobacco is produced, the farm-acreage allotment shall be increased by the smaller of (1) 20 per centum of such allotment or (2) the percentage by which the normal yield of such allotments (as determined through the local committees in accordance with regulations prescribed by the Secretary) is less than three thousand two hundred pounds, in the case of flue-cured tobacco, and two thousand four hundred pounds in the case of other kinds of tobacco: *Provided*, That the normal yield of the estimated number of acres so added to farm acreage allotments in any State shall be considered as a part of the State marketing quota in applying the proviso in subsection (a). The actual production of the acreage allotment established for a farm pursuant to this subsection shall be the amount of the farm marketing quota. If any amount of tobacco shall be marketed as having been produced on the acreage allotment for any farm which in fact was produced on a different farm, the acreage allotments next established for both such farms shall be reduced by that percentage which such amount was of the respective farm marketing quota, except that such reduction for any such farm shall not be made if the Secretary through the local committees finds that no person connected with such farm caused, aided, or acquiesced in such marketing; and if proof of the disposition of any amount of tobacco is not furnished as required by the Secretary or if any producer on the farm files, or aids or acquiesces in the filing of, any false report with respect to the acreage

of tobacco grown on the farm required by regulations issued pursuant to this Act, the acreage allotment next established for the farm on which such tobacco is produced shall be reduced by a percentage similarly computed. If in any calendar year more than one crop of tobacco is grown from (1) the same tobacco plants or (2) different tobacco plants, and is harvested for marketing from the same acreage of a farm, the acreage allotment next established for such farm shall be reduced by an amount equivalent to the acreage from which more than one crop of tobacco has been so grown and harvested. (7 U.S.C. 1313(g).)

(h)[15] * * *

(i) Notwithstanding any other provision of this Act, whenever after investigation the Secretary determines with respect to any kind of tobacco that a substantial difference exists in the usage or market outlets for any one or more of the types comprising such kind of tobacco and that the quantity of tobacco of such type or types to be produced under the marketing quotas and acreage allotments established pursuant to this section would not be sufficient to provide an adequate supply for estimated market demands and carry-over requirements for such type or types of tobacco, the Secretary shall increase the marketing quotas and acreage allotments for farms producing such type or types of tobacco in the preceding year to the extent necessary to make available a supply of such type or types of tobacco adequate to meet such demands and carry-over requirements. The increases in farm marketing quotas and acreage allotments shall be made on the basis of the production of such type or types of tobacco during the period of years considered in establishing farm marketing quotas and acreage allotments for such kind of tobacco. The additional production authorized by this subsection shall be in addition to the national marketing quota established for such kind of tobacco pursuant to section 312 of this Act. The increase in acreage under this subsection shall not be considered in establishing future State or farm acreage allotments. (7 U.S.C. 1313(i).)

(j) In establishing farm acreage allotments for burley tobacco crops for the years 1956, 1957, and 1958 the acreage allotment for any farm which has not been retired from agricultural production shall not be reduced below the acreage allotment which would otherwise be established because the harvested acreage was less than the allotted acreage unless the acreage harvested was less than 50 per centum of the allotted acreage in each of the preceding five years, in which event it shall not be reduced for such reason to less than the largest acreage harvested in any year in such five-year period. (7 U.S.C. 1313(j).)

(j) [sic] [16] The production of tobacco on a farm in 1955 or any subsequent year for which no farm acreage allotment was established shall not make the farm eligible for an allotment as an old farm under subsections (b) and (g) hereof: *Provided*, *however*, That by reason of such production the farm need not be considered as ineligible for a new farm allotment under subsections (c) and (g) hereof, but such production shall not be deemed past tobacco experience for any producer on the farm. (7 U.S.C. 1313(j).)

[15] Sec. 313(h) repealed by Pub. L. 85-835, 72 Stat. 988, approved August 28, 1958.
[16] Subsection (j) to Sec. 313 was added by Pub. L. 361, 84th Cong., 69 Stat. 684, approved August 11, 1955; so in original, probably should be subsec. (k).

PENALTIES

SEC. 314. (a) The marketing of any kind of tobacco in excess of the marketing quota for the farm on which the tobacco is produced shall be subject to a penalty of 75 per centum of the average market price (calculated to the nearest whole cent) for such kind of tobacco for the immediately preceding marketing year. Such penalty shall be paid by the person who acquired such tobacco from the producer but an amount equivalent to the penalty may be deducted by the buyer from the price paid to the producer in case such tobacco is marketed by sale; or, if the tobacco is marketed by the producer through a warehouseman or other agent, such penalty shall be paid by such warehouseman or agent who may deduct an amount equivalent to the penalty from the price paid to the producer: *Provided*, That in case any tobacco is marketed directly to any person outside the United States the penalty shall be paid and remitted by the producer. If any producer falsely identifies or fails to account for the disposition of any tobacco, an amount of tobacco equal to the normal yield of the number of acres harvested in excess of the farm-acreage allotment shall be deemed to have been marketed in excess of the marketing quota for the farm, and the penalty in respect thereof shall be paid and remitted by the producer. Tobacco carried over by the producer thereof from one marketing year to another may be marketed without payment of the penalty imposed by this section if the total amount of tobacco available for marketing from the farm in the marketing year from which the tobacco is carried over did not exceed the farm marketing quota established for the farm for such marketing year (or which would have been established if marketing quotas had been in effect for such marketing year), or if the tobacco so carried over does not exceed the normal production of that number of acres by which the harvested acreage of tobacco in the calendar year in which the marketing year begins is less than the farm-acreage allotment. Tobacco produced in a calendar year in which marketing quotas are in effect for the marketing year beginning therein shall be subject to such quotas even though it is marketed prior to the date on which such marketing year begins. (7 U.S.C. 1314(a).)

(b) The Secretary shall require collection of the penalty upon a proportion of each lot of tobacco marketed from the farm equal to the proportion which the tobacco available for marketing from the farm in excess of the farm marketing quota is of the total amount of tobacco available for marketing from the farm if satisactory proof is not furnished as to the disposition to be made of such excess tobacco prior to the marketing of any tobacco from the farm. All funds collected pursuant to this section shall be deposited in a special deposit account with the Treasurer of the United States until the end of the marketing year next succeeding that in which the funds are collected, and upon certification by the Secretary there shall be paid out of such special deposit account to persons designated by the Secretary the amount by which the penalty collected exceeds the amount of penalty due upon tobacco marketed in excess of the farm marketing quota for any farm. Such special account shall be administered by the Secretary, and the basis for, the amount of, and the person en-

titled to receive a payment from such account, when determined in accordance with regulations prescribed by the Secretary, shall be final and conclusive. (7 U.S.C. 1314(b).)

SEC. 315. (a) The provisions of this section shall be effective, where applicable, notwithstanding any other provision of this Act. Within thirty days after the date this section is enacted into law, the Secretary shall conduct a special referendum of farmers who were engaged in the production of the crops of the type 21 (Virginia) fire-cured tobacco or the type 37 Virginia sun-cured tobacco which was harvested immediately prior to the referendum. The provisions of the regulations issued by the Secretary governing the holding of referendums on marketing quotas authorized under section 312 of this Act shall apply, insofar as applicable, to the holding of the special referendum provided for in this section. The purpose of such special referendum is to determine whether those persons eligible to vote therein favor the establishment, as hereinafter provided in this section, of a single combined tobacco acreage allotment for the 1958–59 and subsequent marketing years for any farm for which both a type 21 (Virginia) fire-cured tobacco acreage allotment and a type 37 Virginia sun-cured tobacco acreage allotment have been established for the 1958–59 marketing year.

(b) If two-thirds or more of the persons voting in the special referendum provided for in this section favor the establishment for the 1958–1959 and subsequent marketing years of a single combined tobacco acreage allotment for any farm having both a type 21 (Virginia) fire-cured tobacco acreage allotment and a type 37 Virginia sun-cured tobacco acreage allotment for the 1958–1959 marketing year, the Secretary, through local committees, shall establish for each of such farms a single combined tobacco acreage allotment for the 1958–1959 marketing year and subsequent marketing years applicable to one kind of tobacco, either type 21 (Virginia) fire-cured tobacco or type 37 Virginia sun-cured tobacco, whichever kind of tobacco the owner of such farm or his representative designates with respect to the 1958–1959 marketing year and notifies the local committee of such designation within a period of time as determined and fixed by the Secretary. In the absence of such a designation and notification by the owner or his representative of any farm for which a single combined tobacco acreage allotment shall be established as provided in this section, the Secretary shall designate such combined allotment for such farm as either a type 21 (Virginia) fire-cured tobacco acreage allotment or a type 37 Virginia sun-cured tobacco acreage allotment after taking into consideration the prevalent kind of tobacco grown in the area in which such farm is located, the curing facilities on such farm, and the proximity and nature of marketing outlets. The single combined tobacco acreage allotment determined as heretofore provided for each farm for the 1958–1959 marketing years shall be in lieu of and shall equal the total of the acreage of the type 21 (Virginia) fire-cured tobacco allotment and the acreage of the type 37 Virginia sun-cured tobacco allotment for the 1958–1959 marketing year established for such farm. No contract entered into under the acreage reserve program for the 1958 crop of type 21 (Virginia) fire-cured tobacco or of the type 37 Virginia sun-cured tobacco shall be

affected by the establishment of a single combined tobacco acreage allotment for a farm as provided in this section. If the establishment of farm acreage allotments as provided in this section are approved in the special referendum as heretofore provided in this section, and thereafter two or more farms, of which one or more has a type 21 (Virginia) fire-cured tobacco allotment and another or more has a type 37 Virginia sun-cured tobacco allotment, are combined and operated as a single farm, a single combined tobacco acreage allotment designated for either type 21 (Virginia) fire-cured tobacco or type 37 Virginia sun-cured tobacco as heretofore provided, shall be established for the combined farm in lieu of and shall equal the total acreage of the allotments for type 21 (Virginia) fire-cured tobacco and type 37 Virginia sun-cured tobacco established for the farms comprising the combined farm for the marketing year for which such single combined tobacco acreage allotment is established. For marketing years subsequent to the marketing year for which a single combined tobacco acreage allotment is first established for a farm as provided in this section, the history of past marketing or of past harvested acreage from such farm of both type 21 (Virginia) fire-cured tobacco and type 37 Virginia sun-cured tobacco shall constitute the past marketing of tobacco or the past harvested acreage of tobacco of such farm in determining a single combined tobacco acreage allotment therefor.

(c) Notwithstanding the national marketing quotas for the marketing year beginning October 1, 1958, announced by the Secretary for each of the two kinds of tobacco described as type 21 (Virginia) fire-cured tobacco and type 37 Virginia sun-cured tobacco, each of the State acreage allotments for such kinds of tobacco apportioned by the Secretary to the State of Virginia for the marketing year beginning October 1, 1958, shall be increased or decreased respectively by the amount of acreage equivalent to the corresponding net total change in farm acreage allotments for each of such kinds of tobacco for such marketing year which result from the establishment of single combined tobacco farm acreage allotments as provided in this section. In determining and announcing the amount of the national marketing quotas for type 21 (Virginia) fire-cured tobacco, and type 37 Virginia sun-cured tobacco in terms of the total quantity of each of such kinds of tobacco which may be marketed during the marketing year beginning October 1, 1959, and during each of the four succeeding marketing years thereafter, the Secretary shall increase or decrease such national marketing quotas determined as provided in section 312 (b) and the Virginia State acreage allotments for type 21 (Virginia) fire-cured tobacco and type 37 Virginia sun-cured tobacco to reflect correspondingly the changes which previously have occurred in the total acreage allotted for each of such kinds of tobacco pursuant to this section. Notwithstanding any marketing quota determined and announced for type 21 (Virginia) fire-cured tobacco and type 37 Virginia sun-cured tobacco for the marketing year beginning October 1, 1959, and for each marketing year thereafter, each of the State acreage allotments for such kinds of tobacco apportioned to the State of Virginia for any such marketing year shall be increased or decreased respectively by the amount of acreage equivalent to the

corresponding net total change in farm acreage allotments for each of such kinds of tobacco for such marketing year which results from the combination of farms and the establishment of single combined tobacco farm acreage allotments as provided in this section. The sum of the State acreage allotments for type 21 (Virginia) fire-cured tobacco and type 37 Virginia sun-cured tobacco determined for any marketing year as provided in section 313 shall not be increased or decreased by reason of any increase or decrease in the State acreage allotment for each of such kinds of tobacco previously provided for in this paragraph to reflect net changes occurring in acreage allotted. (7 U.S.C. 1314a.)

Sec. 316.[17] (a) Notwithstanding any other provision of this Act for the crop years 1962, 1963, 1964, and 1965,[18] the owner and operator of any farm for which a tobacco acreage allotment (other than a Burely tobacco acreage allotment or [19] a cigar-filler and cigar-binder (types 42, 43, 44, 53, 54, and 55) tobacco acreage allotment) is established may lease any part of such allotment to any other owner or operator of a farm in the same county for use in such county on a farm having a current tobacco allotment of the same kind. Such lease and transfer of allotment shall be recognized and considered valid by the county committee provided the conditions set forth in this section are met. In the case of Maryland (type 32) tobacco, no farm shall be eligible for lease of 1962 or 1963 allotment from the farm unless at least 75 per centum of the allotment for the farm was actually planted during each of the years 1960 and 1961, nor shall a farm be eligible for lease of 1964 or 1965 Maryland tobacco allotment from the farm unless at least 75 per centum of the allotment for the farm was actually planted on such farm during each of the two immediately preceding years.[20]

(b)[21] Any lease shall be made on an annual basis and on such terms and conditions, except as otherwise provided in this section, as the parties thereto agree.

(c) The lease and transfer of any allotment shall not be effective until a copy of such lease is filed with and determined by the county committee of the county in which the farms involved are located to be in compliance with the provisions of this section. Such lease and transfer shall not be effective unless a copy of the lease is filed with the county committee prior to a closing date established by the Secretary, which date shall be no later than the normal planting time in the county. If the normal yield established by the county committee for the farm to which the allotment is transferred does not exceed the normal yield established by the county committee for the farm from which the allotment is transferred by more than 10 per centum, the lease and transfer shall be approved acre for acre. If the normal yield for the farm to which the allotment is transferred exceeds the normal yield for the farm from which the allotment is transferred by

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[17] Section 316 added by Pub. L. 87-200, 75 Stat. 469, approved September 6, 1961.

[18] Pub. L. 88-68, 77 Stat. 82, approved July 19, 1963, struck out the word and figures, "and 1963" and inserted in lieu thereof the figures, "1963, 1964, and 1965".

[19] Pub. L. 88-68, 77 Stat. 82 struck out words and figures, ", and for the 1963 crop year, other than" and inserted in lieu thereof the word, "or".

[20] Pub. L. 88-68, 77 Stat. 82 struck out the last sentence of subsection (a) and inserted the language now contained therein.

[21] Pub. L. 88-68, 77 Stat. 82 amended subsection (b) by eliminating the provisions against leases for any period exceeding one year and for renewals of 1963 crop year leases.

more than 10 per centum, the county committee shall make a downward adjustment in the amount of the acreage allotment transferred by multiplying the normal yield established for the farm from which the allotment is transferred by the acreage being transferred and dividing the result by the normal yield established by the farm to which the allotment is transferred.

(d) The lease and transfer of any part of a tobacco acreage allotment determined for a farm shall not affect the allotment for the farm from which such acreage allotment is transferred or the farm to which it is transferred, except with respect to the crop year specified in the lease. The amount of acreage allotment which is leased from a farm shall be considered for purpose of determining future allotments to have been planted to tobacco on the farm from which such allotment is transferred and the production pursuant to the lease and transfer shall not be taken into account in establishing allotments for subsequent years for the farm to which such allotment is transferred. The lessor shall be considered to have been engaged in the production of tobacco for the purpose of eligibility to vote in the referendum.

(e) Under the provisions of this section not more than five acres of allotment may be leased and transferred to any farm: *Provided*, That the total acreage allotted to any farm after such transfer shall not exceed 50 per centum of the acreage of cropland in the farm.

(f) The Secretary shall prescribe such regulations as he considers necessary for carrying out the provisions of this section.

(g) [22] Notwithstanding the provisions of subsection (c) relating to the filing of a lease with the county committee, the lease and transfer of an allotment for the 1964 crop year shall be effective if, (1) the Secretary finds that a lease in compliance with the provisions of this section was agreed upon prior to the normal planting time in the county, as determined by the Secretary, or June 15, 1964, whichever is earlier, and (2) the terms of the lease are reduced to writing and filed in the county office in which the farms involved are located within twenty days of the date the 1964 amendment to this subsection become law.[23] (7 U.S.C. 1314b.)

(h) [24] * * *

Part II—Acreage Allotments—Corn [25]

LEGISLATIVE FINDINGS

Sec. 321. Corn is a basic source of food for the Nation, and corn produced in the commercial corn-producing area moves almost wholly in interstate and foreign commerce in the form of corn, livestock, and livestock products.

Abnormally excessive and abnormally deficient supplies of corn acutely and directly affect, burden, and obstruct interstate and for-

[22] Subsection (g) added by Pub. L. 87–530, 76 Stat. 151, approved July 10, 1962.

[23] Subsection (g) made applicable to the 1964 crop of tobacco by Pub. L. 88–469, 78 Stat. 581, approved August 20, 1964. For similar legislation with respect to the 1962 and 1963 crops, see Pub. L. 87–530, 76 Stat. 151 and Pub. L. 88–80, 77 Stat. 114.

[24] Pub. L. 88–469, 78 Stat. 581, approved August 30, 1964, repealed subsec. (h) which was enacted by Pub. L. 88–80, 77 Stat. 114.

[25] Secs. 321 to 329 not in effect due to results of corn referendum held on November 25, 1958, in which farmers approved a price support program without acreage allotments. See section 104, Agricultural Act of 1949, p. 151, for corn price support program.

eign commerce in corn, livestock, and livestock products. When abnormally excessive supplies exist, transportation facilities in interstate and foreign commerce are overtaxed, and the handling and processing facilities through which the flow of interstate and foreign commerce in corn, livestock, and livestock products is directed become acutely congested. Abnormally deficient supplies result in substantial decreases in livestock production and in an inadequate flow of livestock and livestock products in interstate and foreign commerce, with the consequence of unreasonably high prices to consumers.

Violent fluctuations from year to year in the available supply of corn disrupt the balance between the supply of livestock and livestock products moving in interstate and foreign commerce and the supply of corn available for feeding. When available supplies of corn are excessive, corn prices are low and farmers overexpand livestock production in order to find outlets for corn. Such expansion, together with the relative scarcity and high price of corn, forces farmers to market abnormally excessive supplies of livestock in interstate commerce at sacrifice prices, endangering the financial stability of producers, and overtaxing handling and processing facilities through which the flow of interstate and foreign commerce in livestock and livestock products is directed. Such excessive marketings deplete livestock on farms, and livestock marketed in interstate and foreign commerce consequently becomes abnormally low, with resultant high prices to consumers and danger to the financial stability of persons engaged in transporting, handling, and processing livestock in interstate and foreign commerce. These high prices in turn result in another overexpansion of livestock production.

Recurring violent fluctuations in the price of corn resulting from corresponding violent fluctuations in the supply of corn directly affect the movement of livestock in interstate commerce from the range cattle regions to the regions where livestock is fattened for market in interstate and foreign commerce, and also directly affect the movement in interstate commerce of corn marketed as corn which is transported from the regions where produced to the regions where livestock is fattened for market in interstate and foreign commerce.

Substantially all the corn moving in interstate commerce, substantially all the corn fed to livestock transported in interstate commerce for fattening, and substantially all the corn fed to livestock marketed in interstate and foreign commerce, is produced in the commercial corn-producing area. Substantially all the corn produced in the commercial corn-producing area, with the exception of a comparatively small amount used for farm consumption, is either sold or transported in interstate commerce, or is fed to livestock transported in interstate commerce for feeding, or is fed to livestock marketed in interstate and foreign commerce. Almost all the corn produced outside the commercial corn-producing area is either consumed, or is fed to livestock which is consumed, in the State in which such corn is produced.

The conditions affecting the production and marketing of corn and the livestock products of corn are such that, without Federal assistance, farmers, individually or in cooperation, cannot effectively prevent the recurrence of dispartities between the supplies of livestock

moving in interstate and foreign commerce and the supply of corn available for feeding, and provide for orderly marketing of corn in interstate and foreign commerce and livestock and livestock products in interstate and foreign commerce.

The national public interest requires that the burdens on interstate and foreign commerce above described be removed by the exercise of Federal power. By reason of the administrative and physical impracticability of regulating the movement of livestock and livestock products in interstate and foreign commerce and the inadequacy of any such regulation to remove such burdens, such power can be feasibility exercised only by providing for the withholding from market of excessive and burdensome supplies of corn in times of excessive production, and providing a reserve supply of corn available for market in times of deficient production, in order that a stable and continuous flow of livestock and livestock products in interstate and foreign commerce may at all times be assured and maintained. (7 U.S.C. 1321.)

FARM MARKETING QUOTAS

SECS. 322 to 325.[26] * * *

ADJUSTMENT OF FARM MARKETING QUOTAS

[SEC. 326 below repealed by 68 Stat. 902 insofar as applicable to corn; (b) and (c) below are still applicable to wheat. See paragraph (6), Pub. L. 74, 77th Congress, on p. 63.]

SEC. 326. (a) Whenever in any county or other area the Secretary finds that the actual production of corn plus the amount of corn stored under seal in such county or other area is less than the normal production of the marketing percentage of the farm acreage allotments in such county or other area, the Secretary shall terminate farm marketing quotas for corn in such county or other area. (7 U.S.C. 1326(a).)

(b) Whenever, upon any farm, the actual production of the acreage of corn is less than the normal production of the marketing percentage of the farm acreage allotment, there may be marketed, without penalty, from such farm an amount of corn from the corn stored under seal pursuant to section 324 which, together with the actual production of the then current crop, will equal the normal production of the marketing percentage of the farm acreage allotment. (7 U.S.C. 1326(b).)

(c) Whenever, in any marketing year, marketing quotas are not in effect with respect to the crop of corn produced in the calendar year in which such marketing year begins, all marketing quotas applicable to previous crops of corn shall be terminated. (7 U.S.C. 1326(c).)

PROCLAMATION OF COMMERCIAL CORN-PRODUCING AREA

SEC. 327. Not later than February 1 of each calendar year, the Secretary shall ascertain and proclaim the commercial corn-producing area. (7 U.S.C. 1327.)

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[26] Secs. 322 to 325, which related to marketing quotas for corn, were repealed by Pub. L. 690, 83d Cong., 68 Stat. 902, approved August 28, 1954.

ACREAGE ALLOTMENT

SEC. 328. The acreage allotment of corn for any calendar year shall be that acreage in the commercial corn-producing area which, on the basis of the average yield for corn in such area during the five calendar years immediately preceding such calendar year, adjusted for abnormal weather conditions, will produce an amount of corn in such area which the Secretary determines will, together with corn produced in the United States outside the commercial corn-producing area and corn imported, make available a supply for the marketing year beginning in such calendar year, equal to the normal supply. The Secretary shall proclaim such acreage allotment not later than February 1 of the calendar year for which such acreage allotment was determined. (7 U.S.C. 1328.)

APPORTIONMENT OF ACREAGE ALLOTMENT

SEC. 329. (a) The acreage allotment for corn shall be apportioned by the Secretary among the counties in the commercial corn-producing area on the basis of the acreage seeded for the production of corn during the five calendar years immediately preceding the calendar year in which the apportionment is determined (plus, in applicable years, the acreage diverted under previous agricultural adjustment and conservation programs), with adjustments for abnormal weather conditions and for trends in acreage during such period and for the promotion of soil-conservation practices: *Provided*, That any downward adjustment for the promotion of soil-conservation practices shall not exceed 2 per centum of the total acreage allotment that would otherwise be made to such county. (7 U.S.C. 1329(a).)

(b) The acreage allotment to the county for corn shall be apportioned by the Secretary, through the local committees, among the farms within the county on the basis of tillable acreage, crop-rotation practices, type of soil, and topography. (7 U.S.C. 1329 (b).)

NONESTABLISHMENT OF ACREAGE ALLOTMENTS

SEC. 330.[27] Notwithstanding any other provision of law, acreage allotments and a commercial corn-producing area shall not be established for the 1959 and subsequent crops of corn. (7 U.S.C. 1441 note.)

PART III—MARKETING QUOTAS—WHEAT

LEGISLATIVE FINDINGS

SEC. 331.[28] Wheat is a basic source of food for the Nation, is produced throughout the United States by more than a million farmers, is sold on the country-wide market and, as wheat or flour, flows almost entirely through instrumentalities of interstate and foreign commerce from producers to consumers.

Abnormally excessive and abnormally deficient supplies of wheat on the country-wide market acutely and directly affect, burden, and obstruct interstate and foreign commerce. Abnormally excessive

[27] This section is effective since farmers voting in a referendum which was held on November 25, 1958, voted in favor of no allotments and a price support program as outlined in section 104, Agricultural Act of 1949, as amended (see p. 151).

[28] The last three paragraphs were added by Pub. L. 87–703, 76 Stat. 619, approved September 27, 1962.

supplies overtax the facilities of interstate and foreign transportation, congest terminal markets and milling centers in the flow of wheat from producers to consumers, depress the price of wheat in interstate and foreign commerce, and otherwise disrupt the orderly marketing of such commodity in such commerce. Abnormally deficient supplies result in an inadequate flow of wheat and its products in interstate and foreign commerce with consequent injurious effects to the instrumentalities of such commerce and with excessive increases in the prices of wheat and its products in interstate and foreign commerce.

It is in the interest of the general welfare that interstate and foreign commerce in wheat and its products be protected from such burdensome surpluses and distressing shortages, and that a supply of wheat be maintained which is adequate to meet domestic consumption and export requirements in years of drought, flood, and other adverse conditions as well as in years of plenty, and that the soil resources of the Nation be not wasted in the production of such burdensome surpluses. Such surpluses result in disastrously low prices of wheat and other grains to wheat producers, destroy the purchasing power of grain producers for industrial products, and reduce the value of the agricultural assets supporting the national credit structure. Such shortages of wheat result in unreasonably high prices of flour and bread to consumers and loss of market outlets by wheat producers.

The conditions affecting the production and marketing of wheat are such that, without Federal assistance, farmers, individually or in cooperation, cannot effectively prevent the recurrence of such surpluses and shortages and the burdens on interstate and foreign commerce resulting therefrom, maintain normal supplies of wheat, or provide for the orderly marketing thereof in interstate and foreign commerce.

Wheat which is planted and not disposed of prior to the date prescribed by the Secretary for the disposal of excess acres of wheat is an addition to the total supply of wheat and has a direct effect on the price of wheat in interstate and foreign commerce and may also affect the supply and price of livestock and livestock products. In the circumstances, wheat not disposed of prior to such date must be considered in the same manner as mechanically harvested wheat in order to achieve the policy of the Act.

The diversion of substantial acreages from wheat to the production of commodities which are in surplus supply or which will be in surplus supply if they are permitted to be grown on the diverted acreage would burden, obstruct, and adversely affect interstate and foreign commerce in such commodities, and would adversely affect the prices of such commodities in interstate and foreign commerce. Small changes in the supply of a commodity could create a sufficient surplus to affect seriously the price of such commodity in interstate and foreign commerce. Large changes in the supply of such commodity could have a more acute effect on the price of the commodity in interstate and foreign commerce and, also, could overtax the handling, processing, and transportation facilities through which the flow of interstate and foreign commerce in such commodity is directed. Such adverse effects caused by overproduction in one year could further result in a deficient supply of the commodity in the succeeding year, causing excessive increases in the price of the commodity in interstate and foreign com-

merce in such year. It is, therefore, necessary to prevent acreage diverted from the production of wheat to be used to produce commodities which are in surplus supply or which will be in surplus supply if they are permitted to be grown on the diverted acreage.

The provisions of this part affording a cooperative plan to wheat producers are necessary in order to minimize recurring surpluses and shortages of wheat in interstate and foreign commerce, to provide for the maintenance of adequate reserve supplies thereof, to provide for an adequate and orderly flow of wheat and its products in interstate and foreign commerce at prices which are fair and reasonable to farmers and consumers, and to prevent acreage diverted from the production of wheat from adversely affecting other commodities in interstate and foreign commerce. (7 U.S.C. 1331.)

PROCLAMATIONS OF SUPPLIES AND ALLOTMENTS

SEC. 332.[29] (a) Whenever prior to April 15 in any calendar year the Secretary determines that the total supply of wheat in the marketing year beginning in the next succeeding calendar year will, in the absence of a marketing quota program, likely be excessive, the Secretary shall proclaim that a national marketing quota for wheat shall be in effect for such marketing year and for either the following marketing year or the following two marketing years, if the Secretary determines and declares in such proclamation that a two- or three-year marketing quota program is necessary to effectuate the policy of the Act. (7 U.S.C. 1332(a).)

(b) If a national marketing quota for wheat has been proclaimed for any marketing year, the Secretary shall determine and proclaim the amount of the national marketing quota for such marketing year not earlier than January 1 or later than April 15 of the calendar year preceding the year in which such marketing year begins. The amount of the national marketing quota for wheat for any marketing year shall be an amount of wheat which the Secretary estimates (i) will be utilized during such marketing year for human consumption in the United States as food, food products, and beverages, composed wholly or partly of wheat, (ii) will be utilized during such marketing year in the United States for seed, (iii) will be exported either in the form of wheat or products thereof, and (iv) as the average amount which was utilized as livestock (including poultry) feed in the marketing years beginning in 1959 and 1960; less (A) an amount of wheat equal to the estimated imports of wheat into the United States during such marketing year and, (B) if the stocks of wheat owned by the Commodity Credit Corporation are determined by the Secretary to be excessive, an amount of wheat determined by the Secretary to be a desirable reduction in such marketing year in such stocks to achieve the policy of the Act: *Provided*, That if the Secretary determines that the total stocks of wheat in the Nation are insufficient to assure an adequate carryover for

[29] A new section 332 was enacted by Pub. L. 87–703, 76 Stat. 620, approved September 27, 1962. For the text of old section 332, see Pub. L. 690, 83d Cong., 68 Stat. 903, approved August 28, 1954. The proclamations were deferred to June 1, 1959 for the 1960 crop year and July 15, 1962 for the 1963 crop year.

the next succeeding marketing year, the national marketing quota otherwise determined shall be increased by the amount the Secretary determines to be necessary to assure an adequate carryover: *And provided further*, That the national marketing quota for wheat for any marketing year shall be not less than one billion bushels. (7 U.S.C. 1332(b).)

(c) If, after the proclamation of a national marketing quota for wheat for any marketing year, the Secretary has reason to believe that, because of a national emergency or because of a material increase in the demand for wheat, the national marketing quota should be terminated or the amount thereof increased, he shall cause an immediate investigation to be made to determine whether such action is necessary in order to meet such emergency or increase in the demand for wheat. If, on the basis of such investigation, the Secretary finds that such action is necessary, he shall immediately proclaim such finding and the amount of any such increase found by him to be necessary and thereupon such national marketing quota shall be so increased or terminated. In case any national marketing quota is increased under this subsection, the Secretary shall provide for such increase by increasing acreage allotments established under this part by a uniform percentage. (7 U.S.C. 1332(c).)

[Pub. L. 88–297.[30] SEC. 201. Notwithstanding any other provision of law—

(1) the Secretary shall not proclaim a national marketing quota for the 1965 crop of wheat and farm marketing quotas shall not be in effect for such crop of wheat;

(2) the Secretary shall proclaim a national acreage allotment for the 1965 crop of wheat which shall be the number of acres which the Secretary determines will make available an adequate supply of wheat, but shall not be less than forty-nine million five hundred thousand acres.]

NATIONAL ACREAGE ALLOTMENT

SEC. 333.[31] Whenever the amount of the national marketing quota for wheat is proclaimed for any marketing year, the Secretary at the same time shall proclaim a national acreage allotment for the crop of wheat planted for harvest in the calendar year in which such marketing year begins. The amount of the national acreage allotment for any crop of wheat shall be the number of acres which the Secretary determines on the basis of expected yields and expected underplantings of farm acreage allotments will, together with (1) the expected production on the increases in acreage allotments for farms based upon small-farm base acreages pursuant to section 335, and (2) the expected production on increased acreages resulting from the small-farm exemption pursuant to section 335, make available a supply of wheat equal to the national marketing quota for wheat for such marketing year. (7 U.S.C. 1333.)

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[30] 78 Stat. 178, approved April 11, 1964.

[31] Pub. L. 87–703, 76 Stat. 620, approved September 27, 1962, enacted a new section 333. For old section 333 which was in effect for 1963 and prior crops of wheat, see Pub. L. 430, 75th Cong., 52 Stat. 53, and the amendments thereto contained in Pub. Res. No. 118, 75th Cong., 52 Stat. 775, Pub. Res. No. 33, 76th Cong., 53 Stat. 1125, and Pub. L. 897, 80th Cong., 62 Stat. 1257.

APPORTIONMENT OF NATIONAL ACREAGE ALLOTMENT

SEC. 334. (a)[32] The national acreage allotment for wheat, less a reserve of not to exceed one per centum thereof for apportionment as provided in this subsection and less the special acreage reserve provided for in this subsection, shall be apportioned by the Secretary among the several States on the basis of the acreage seeded for the production of wheat during the ten calendar years immediately preceding the calendar year in which the national acreage allotment is determined (plus, in applicable years, the acreage diverted under previous agricultural adjustment and conservation programs), with adjustments for abnormal weather conditions and for trends in acreage during such period: *Provided*, That in establishing State acreage allotments the acreage seeded for the production of wheat plus the acreage diverted for 1959 and any subsequent year for any farm on which the entire amount of the farm marketing excess is delivered to the Secretary or stored in accordance with applicable regulations to avoid or postpone payment of the penalty shall be the base acreage of wheat determined for the farm under the regulations issued by the Secretary for determining farm wheat acreage allotments for such year, but if any part of the amount of wheat so stored is later depleted and penalty becomes due by reason of such depletion, for the purpose of establishing State wheat acreage allotments subsequent to such depletion the seeded plus diverted acreage of wheat for the farm for the year in which the excess was produced shall be reduced to the farm wheat acreage allotment for such year: *Provided further*, That in establishing State acreage allotments, the acreage seeded for the production of wheat plus the acreage diverted for 1965 for any farm shall be the base acreage of wheat determined for the farm under the regulations issued by the Secretary for determining farm wheat acreage allotments for such year. The reserve acreage set aside herein for apportionment by the Secretary shall be used to make allotments to counties, in addition to the county allotments made under subsection (b) of this section, on the basis of the relative needs of counties for additional allotment because of reclamation and other new areas coming into the production of wheat during the ten calendar years ending with the calendar year in which the national acreage allotment is proclaimed. There shall also be made available, beginning with the 1965 crop, a special acreage reserve of not in excess of one million acres as determined by the Secretary to be desirable for the purposes hereof which shall be in addition to the national acreage reserve provided for in this subsection. Such special acreage reserve shall be used to make additional allotments to counties on the basis of the relative needs of counties, as determined by the Secretary, for additional allotments to make adjustments in the allotments on old wheat farms (i.e., farms on which wheat has been seeded or regarded as seeded to one or more of the three crops immediately preceding the crop for which the allotment is established) on which the ratio of wheat acreage allotment to cropland on the

[32] Subsection (a) was amended by Pub. L. 88–297, 78 Stat. 178, approved April 11, 1964, by adding in the first sentence the language, "and less the special acreage reserve provided for in this subsection"; by adding a second proviso; and by adding the last five sentences in said subsection.

farm is less than one-half the average ratio of wheat acreage allotment to cropland on old wheat farms in the county. Such adjustments shall not provide an allotment for any farm which would result in an allotment-cropland ratio for the farm in excess of one-half of such county average ratio and the total of such adjustments in any county shall not exceed the acreage made available therefor in the county. Such apportionment from the special acreage reserve shall be made only to counties where wheat is a major income-producing crop, only to farms on which there is limited opportunity for the production of an alternative income-producing crop, and only if an efficient farming operation on the farm requires the allotment of additional acreage from the special acreage reserve. For the purposes of making adjustments hereunder the cropland on the farm shall not include any land developed as cropland subsequent to the 1963 crop year (7 U.S.C. 1334(a).)

(b)[33] The State acreage allotment for wheat, less a reserve of not to exceed 3 per centum thereof for apportionment as provided in subsection (c) of this section, shall be apportioned by the Secretary among the counties in the State, on the basis of the acreage seeded for the production of wheat during the ten calendar years immediately preceding the calendar year in which the national acreage allotment is determined (plus, in applicable years, the acreage diverted under previous agricultural adjustment and conservation programs), with adjustments for abnormal weather conditions and trends in acreage during such period and for the promotion of soil-conservation practices: *Provided*, That in establishing county acreage allotments the acreage seeded for the production of wheat plus the acreage diverted for 1959 and any subsequent year for any farm on which the entire amount of the farm marketing excess is delivered to the Secretary or stored in accordance with applicable regulations to avoid or postpone payment of the penalty shall be the base acreage of wheat determined for the farm under the regulations issued by the Secretary for determining farm wheat acreage allotments for such year, but if any part of the amount of wheat so stored is later depleted and penalty becomes due by reason of such depletion, for the purpose of establishing county acreage allotments subsequent to such depletion the seeded plus diverted acreage of wheat for the farm for the year in which the excess was produced shall be reduced to the farm wheat acreage allotment for such year: *Provided further*, That in establishing county acreage allotments, the acreage seeded for the production of wheat plus the acreage diverted for 1965 for any farm shall be the base acreage of wheat determined for the farm under the regulations issued by the Secretary for determining farm wheat acreage allotments for such year. (7 U.S.C. 1334(b).)

(c)(1)[34] The allotment to the county shall be apportioned by the Secretary, through the local committees, among the farms within the county on the basis of past acreage of wheat, tillable acres, crop-rotation practices, type of soil, and topography. Not more than 3 percentum of the State allotment shall be appor-

[33] Subsection (b) was amended by Pub. L. 88–297, 78 Stat. 178, approved April 11, 1964, by adding a second proviso.

[34] Words and figures, "or 1965" and "except 1965", were added in the third sentence of subsection (c)(1) by Pub. L. 88–297, 78 Stat. 178, approved April 11, 1964.

tioned to farms on which wheat has not been planted during any of the three marketing years immediately preceding the marketing year in which the allotment is made. For the purpose of establishing farm acreage allotments—(i) the past acreage of wheat on any farm for 1958 or 1965 shall be the base acreage determined for the farm under the regulations issued by the Secretary for determinnig 1958 or 1965 farm wheat acreage allotments; (ii) if subsequent to the determination of such base acreage the 1958 or 1965 wheat acreage allotment for the farm is increased through administrative, review, or court proceedings, the 1958 or 1965 farm base acreage shall be increased in the same proportion; and (iii) the past acreage of wheat for 1959 and any subsequent year except 1965 shall be the wheat acreage on the farm which is not in excess of the farm wheat acreage allotment, plus, in the case of any farm which is in compliance with its farm wheat acreage allotment, the acreage diverted under such wheat allotment programs: *Provided*, That for 1959 and subsequent years in the case of any farm on which the entire amount of the farm marketing excess is delivered to the Secretary or stored in accordance with applicable regulations to avoid or postpone payment of the penalty, the past acreage of wheat for the year in which such farm marketing excess is so delivered or stored shall be the farm base acreage of wheat determined for the farm under the regulations issued by the Secretary for determining farm wheat acreage allotments for such year, but if any part of the amount of wheat so stored is later depleted and penalty becomes due by reason of such depletion, for the purpose of establishing farm wheat acreage allotments subsequent to such depletion the past acreage of wheat for the farm for the year in which the excess was produced shall be reduced to the farm wheat acreage allotment for such year.

(2) Notwithstanding any other provision of law, each old or new farm acreage allotment for the 1962 crop of wheat as determined on the basis of a minimum national acreage allotment of fifty-five million acres shall be reduced by 10 per centum. In the event notices of farm acreage allotments for the 1962 crop of wheat have been mailed to farm operators prior to the effective date of this subparagraph (2), new notices showing the required reduction shall be mailed to farm operators as soon as practicable. (7 U.S.C. 1334(c).)

(d) For the purposes of subsections (a), (b), and (c) of this section, any farm—

(1) to which a wheat marketing quota is applicable; and

(2) on which the acreage planted to wheat exceeds the farm wheat acreage allotment; and

(3) on which the marketing excess is zero

shall be regarded as a farm on which the entire amount of the farm marketing excess has been delivered to the Secretary or stored in accordance with applicable regulations to avoid or postpone the payment of the penalty. This subsection shall be applicable in establishing the acreage seeded and diverted and the past acreage of wheat for 1959 and subsequent years in the apportionment of allotments

beginning with the 1961 crop of wheat. For the purpose of clause (1) of this subsection, a farm with respect to which an exemption has been granted under section 335(f) for any year shall not be regarded as a farm to which a wheat marketing quota is applicable for such year, even though such exemption should become null and void because of a violation of the conditions of the exemption. (7 U.S.C. 1334(d).)

(e)[35] (Applicable only with respect to the 1962 and 1963 crops of wheat).

(f)[36] (Applicable only with respect to the 1955, 1956 and 1957 crops of wheat).

(g)[37] Notwithstanding any other provision of law, no acreage in the commercial wheat-producing area seeded to wheat for harvest as grain in 1958 or thereafter except 1965 in excess of acreage allotments shall be considered in establishing future State and county acreage allotments except as prescribed in the provisos to the first sentence of subsections (a) and (b), respectively, of this section. The planting on a farm in the commercial wheat-producing area of wheat of the 1958 or any subsequent crop for which no farm wheat acreage allotment was established shall not make the farm eligible for an allotment as an old farm pursuant to the first sentence of subsection (c) of this section nor shall such farm by reason of such planting be considered ineligible for an allotment as a new farm under the second sentence of such subsection. (7 U.S.C. 1334(g).)

(h)[38] (Omitted.)

(i)[39] If, with respect to any crop of wheat, the Secretary finds that the acreage allotments of farms producing any type of wheat are inadequate to provide for the production of a sufficient quantity of such type of wheat to satisfy the demand therefor, the wheat acreage allotment for such crop for each farm located in a county designated by the Secretary as a county which (1) is capable of producing such type of wheat, and (2) has produced such type of wheat for commercial food products during one or more of the five years immediately preceding the year in which such crop is harvested, shall be increased by such uniform percentage as he deems necessary to provide for such quantity. No increase shall be made under this subsection in the wheat acreage allotment of any farm for any crop if any wheat other than such type of wheat is planted on such farm for such crop. Any increases in

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[35] Subsection (e) was enacted by Pub. L. 87–128, 75 Stat. 300, approved August 8, 1961, and it was applicable with respect to the 1962, 1963 and 1964 crops of durum wheat. However, Pub. L. 87–703, 76 Stat. 620, approved September 27, 1962, amended this subsection to make it applicable only with respect to the 1962 and 1963 crops of durum wheat.

[36] Subsection (f) was originally enacted by Pub. L. 690, 83d Cong., 68 Stat. 903, approved August 28, 1954; however, it was applicable only to the 1955 crop of wheat. Pub. L. 540, 84th Cong., 70 Stat. 203, approved May 28, 1956, amended this subsection to make it applicable with respect to the 1956 and 1957 crops of wheat.

[37] Originally enacted as subsection (h). This subsection was redesignated subsection (g) for the 1964 and subsequent crops and old subsection (g) was repealed by Pub. L. 87–703, 76 Stat. 620, approved September 27, 1962. Redesignated subsection (g) was further amended by Pub. L. 88–297, 78 Stat. 179, approved April 11, 1964, which added the phrase, "except 1965" after the word, "thereafter" in the first sentence.

[38] There is no subsec. (h) for 1964 and subsequent crops because sec. 331(2) of Pub. L. 87–703, approved September 27, 1962, redesignated subsec. (i) (so designated through the 1963 crop) as subsec. (h) for the 1964 and subsequent crops. However, before the redesignation could take place for the 1964 crop year, sec. 1(a) of Pub. L. 88–64, approved July 17, 1963, redesignated the same subsec. (i) (so designated through the 1963 crop) as subsec. (j). Therefore, former subsec. (i) now appears as subsec. (j).

[39] New subsection (i) was added by Pub. L. 87–703, 76 Stat. 620, approved September 27, 1962.

wheat acreage allotments authorized by this subsection shall be in addition to the National, State, and county wheat acreage allotments, and such increases shall not be considered in establishing future State, county, and farm allotments. The provisions of paragraph (6) of Public Law 74, Seventy-seventh Congress (7 U.S.C. 1340(6)), and section 326(b) of this Act, relating to the reduction of the storage amount of wheat shall apply to the allotment for the farm established without regard to this subsection and not to the increased allotment under this subsection. The land-use provisions of section 339 shall not be applicable to any farm receiving an increased allotment under this subsection and the producers on such farms shall not be required to comply with such provisions as a condition of eligibility for price support. (7 U.S.C. 1334(i).)

(j)[40] (Applicable only to the 1958 through 1963 crops of wheat).

(k)[41] Notwithstanding any other provision of this Act, if the Secretary determines that because of a natural disaster a portion of the farm wheat acreage allotments in a county cannot be timely planted or replanted, he may authorize the transfer of all or a part of the wheat acreage allotment for any farm in the county so affected to another farm in the county or in an adjoining county on which one or more of the producers on the farm from which the transfer is to be made will be engaged in the production of wheat and will share in the proceeds thereof, in accordance with such regulations as the Secretary may prescribe. Any farm allotment transferred under this subsection shall be deemed to be planted on the farm from which it was transferred for the purposes of acreage history credits under this Act. (7 U.S.C. 1334(k).)

COMMERCIAL AREA

SEC. 334a.[42] If the acreage allotment for any State for any crop of wheat is twenty-five thousand acres or less, the Secretary, in order to promote efficient administration of this Act and the Agricultural Act of 1949, may designate such State as outside the commercial wheat-producing area for the marketing year for such crop. If such State is so designated, acreage allotments for such crop and marketing quotas for the marketing year therefor shall not be applicable to any farm in such State. Acreage allotments in any State shall not be increased by reason of such designation. (7 U.S.C. 1334b.)

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[40] Subsection (j) was originally enacted as subsection (i) by Pub. L. 85–390, approved May 1, 1958, effective with respect to the 1958 and 1959 crops. Pub. L. 86–385, 74 Stat. 4, approved February 20, 1960, amended this subsection to make it effective with respect to the 1960 and 1961 crops. Pub. L. 87–357, 75 Stat. 778, approved October 4, 1961, made it effective with respect to the 1962 and 1963 crops. It was redesignated subsection (h) for the 1964 and subsequent crops by Pub. L. 87–703, 76 Stat. 620, approved September 27, 1962. However, before the redesignation to subsection (h) could take place for the 1964 and subsequent crops, this subsection was further amended by Pub. L. 88–64, 77 Stat. 80, approved July 17, 1963, which redesignated it as subsection (j) and made it applicable only to privately owned land and increased from eight to twelve thousand acres the total acreage allotment for the area.

[41] New subsection (k) was added by Pub. L. 88–297, 78 Stat. 179, approved April 11, 1964.

[42] New section 334a was added by Pub. L. 87–703, 76 Stat. 621, approved September 27, 1962.

SMALL FARM EXEMPTION

SEC. 335.[43] Notwithstanding any other provision of this part, no farm marketing quota for any crop of wheat shall be applicable to any farm with a farm acreage allotment of less than fifteen acres if the acreage of such crop of wheat does not exceed the small-farm base acreage determined for the farm, unless the operator elects in writing on a form and within the time prescribed by the Secretary to be subject to the farm acreage allotment and marketing quota. The small-farm base acreage for a farm shall be the smaller of (A) the average acreage of the crop of wheat planted for harvest in the three years 1959, 1960, and 1961, or such later three-year period, excluding 1963, determined by the Secretary to be representative, with adjustments for abnormal weather conditions, established crop-rotation practices on the farm, and such other factors as the Secretary determines should be considered for the purpose of establishing a fair and equitable small-farm base acreage, or (B) fifteen acres. The acreage allotment for any farm shall be the larger of (1) the small-farm base acreage determined as provided above on the basis of the three-year period 1959–1961, reduced by the same percentage by which the national acreage allotment for the crop is reduced below fifty-five million acres, or (2) the acreage allotment determined without regard to (1) above. If the operator of any such farm fails to make such election with respect to any crop of wheat, (i) for the purposes of Public Law 74, Seventy-seventh Congress (7 U.S.C. 1340), as amended, the farm acreage allotment for such crop of wheat shall be deemed to be the larger of (A) the small-farm base acreage or (B) the acreage allotment for the farm, (ii) the land-use provisions of section 339 shall be inapplicable to the farm, (iii) such crop of wheat shall not be eligible for price support, and (iv) wheat marketing certificates applicable to such crop shall not be issued with respect to the farm. The additional acreage required to provide acreage allotments for farms based upon small-farm base acreages under this section shall be in addition to National, State, and county acreage allotments. (7 U.S.C. 1335.)

[Pub. L. 74, 77th Cong.[44] (Pub. L. 74 not applicable to corn. See Act of August 28, 1954, 68 Stat. 905).

That notwithstanding the provisions of the Agricultural Adjustment Act of 1938, as amended (hereinafter referred to as the Act)—

(1)[45] The farm marketing quota for any crop of wheat shall be the actual production of the acreage planted to such crop of wheat

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[43] Pub. L. 87–703, 76 Stat. 621, approved September 27, 1962, amended section 335 effective for the 1964 and subsequent crops. For the language of old section 335 (a), (b), (c), (e) and (f) which was applicable with respect to the 1963 and prior crops of wheat, see Pub. L. 430, 75th Cong., 52 Stat. 54, approved February 16, 1938, as amended by Pub. Res. No. 35, 76th Cong., 53 Stat. 1126, approved July 26, 1939, and Pub. L. 897, 80th Cong., 62 Stat. 1256, approved July 3, 1948, and Pub. L. 690, 83d Cong., 68 Stat. 903, approved August 28, 1954. Former subsection (d) was repealed by Pub. L. 87–128, 75 Stat. 297, approved August 8, 1961.

[44] Pub. L. 74, 77th Cong., 55 Stat. 203, approved May 26, 1941.

[45] Paragraph (1) was amended by Pub. L. 87–703, 76 Stat. 624, approved September 27, 1962, and is effective with respect to the 1964 and subsequent crops of wheat. For the text of paragraph (1) which was in effect for the 1962 crop of wheat, see Pub. L. 87–128, 75 Stat. 296, approved August 8, 1961. For the language of paragraph (1) which was in effect with respect to the 1963 crop of wheat, see Pub. L. 74, 77th Cong., 55 Stat. 203, approved May 26, 1941.

on the farm less the farm marketing excess. The farm marketing excess shall be an amount equal to twice the normal yield of wheat per acre established for the farm multiplied by the number of acres of such crop of wheat on the farm in excess of the farm acreage allotment for such crop unless the producer, in accordance with regulations issued by the Secretary and within the time prescribed therein, establishes to the satisfaction of the Secretary the actual production of such crop of wheat on the farm. If such actual production is so established, the farm marketing excess shall be an amount equal to the actual production of the number of acres of wheat on the farm in excess of the farm acreage allotment for such crop. In determining the farm marketing quota and farm marketing excess, any acreage of wheat remaining after the date prescribed by the Secretary for the disposal of excess acres of wheat shall be included as acreage of wheat on the farm, and the production thereof shall be appraised in such manner as the Secretary determines will provide a reasonably accurate estimate of such production. Any acreage of wheat disposed of in accordance with regulations issued by the Secretary prior to such date as may be prescribed by the Secretary shall be excluded in determining the farm marketing quota and farm marketing excess. Self-seeded (volunteer) wheat shall be included in determining the acreage of wheat. Marketing quotas for any marketing year shall be in effect with respect to wheat harvested in the calendar year in which such marketing year begins notwithstanding that the wheat is marketed prior to the beginning of such marketing year. (7 U.S.C. 1340.)

(2)[46] Whenever farm marketing quotas are in effect with respect to any crop of wheat, the producers on a farm shall be subject to a penalty on the farm marketing excess of wheat at a rate per bushel equal to 65 per centum of the parity price per bushel of wheat as of May 1 of the calendar year in which the crop is harvested. Each producer having an interest in the crop of wheat on any farm for which a farm marketing excess of wheat is determined shall be jointly and severally liable for the entire amount of the penalty on the farm marketing excess.

(3) [47] The farm marketing excess for wheat shall be regarded as available for marketing, and the penalty and the storage amount or amounts to be delivered to the Secretary of the commodity shall be computed upon twice the normal production of the excess acreage. Where, upon the application of the producer for an adjustment of

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[46] Paragraph (2) was amended by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962, effective with respect to the 1964 and subsequent crops of wheat, to provide that the penalty rate is 65 per centum of the parity price. For the text of paragraph (2) effective only for the 1962 crop of wheat in regard to penalty rate, see Pub. L. 87–128, 75 Stat. 296, approved August 8, 1961. For the language of paragraph (2) which is in effect as to the 1963 rate of penalty on wheat, see Pub. L. 117, 83d Cong., 67 Stat. 151, approved July 14, 1953, which amended the original paragraph (2) enacted by Pub. L. 74, 77th Cong., 55 Stat. 203, approved May 26, 1941.

[47] Paragraph (3) was amended by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962, which deleted the words, "corn and", in the first sentence; by adding the word, "twice" before the word, "the" and after the word, "upon" in the first sentence; by adding the word, "twice" before the word, "the" and after the word, "than" in the second sentence; by adding the words, "twice the" before the word, "normal" and after the word, "of" in the second sentence and by deleting the words, "corn or" in the last sentence. This amendment is effective with the 1963 and subsequent crops of wheat. For the wording of paragraph (3) which was applicable to the 1962 crop of wheat, see Pub. L. 87–128, 75 Stat. 296, approved August 8, 1961.

penalty or of storage, it is shown to the satisfaction of the Secretary that the actual production of the excess acreage is less than twice the normal production thereof, the difference between the amount of the penalty or storage as computed upon the basis of twice the normal production and as computed upon the basis of actual production shall be returned to or allowed the producer. The Secretary shall issue regulations under which the farm marketing excess of the commodity for the farm may be stored or delivered to him. Upon failure to store or deliver to the Secretary the farm marketing excess within such time as may be determined under regulations prescribed by the Secretary, the penalty computed as aforesaid shall be paid by the producer. Any wheat delivered to the Secretary hereunder shall become the property of the United States and shall be disposed of by the Secretary for relief purposes in the United States or in foreign countries or in such other manner as he shall determine will divert it from the normal channels of trade and commerce.

(4)[48] Until the producers on any farm store, deliver to the Secretary, or pay the penalty on, the farm marketing excess of any crop of wheat, the entire crop of wheat produced on the farm and any subsequent crop of wheat subject to marketing quotas in which the producer has an interest shall be subject to a lien in favor of the United States for the amount of the penalty.

(5) [49] The penalty upon wheat stored shall be paid by the producer at the time, and to the extent, of any depletion in the amount of the commodity so stored, except depletion resulting from some cause beyond the control of the producer.

(6) [49] Whenever the planted acreage of the then current crop of wheat on any farm is less than the farm acreage allotment for such commodity, the total amount of the commodity from any previous crops required to be stored in order to postpone or avoid payment of penalty shall be reduced by that amount which is equal to the normal production of the number of acres by which the farm acreage allotment exceeds the planted acreage. The provisions of section 326 (b) and (c) of the Act shall be applicable also to wheat.

(7) [50] Until the farm marketing excess of wheat is stored or delivered to the Secretary or the penalty thereon is paid, each bushel of the commodity produced on the farm which is sold by the producer to any person within the United States shall be subject to the penalty as specified in paragraph (2) of this resolution. Such penalty shall be paid by the buyer, who may deduct an amount equivalent to the penalty from the price paid to the producer. If the buyer fails to collect such penalty, such buyer and all persons entitled to share in

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[48] Paragraph (4) was added by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962, effective with respect to the 1964 and subsequent crops of wheat. For the text of paragraph (4) which was in effect with respect to the 1963 and prior crops of wheat, see Pub. L. 74, 77th Cong., 55 Stat. 204, approved May 26, 1941.

[49] Paragraphs (5) and (6) were amended by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962, which deleted the words, "corn or".

[50] Original paragraph (7) was repealed by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962, which also renumbered paragraphs (8) through (11) as paragraphs (7) through (10). The new paragraph (7) was further amended by said law which deleted the words, "corn or" and "as the case may be" from the first sentence and added the last sentence to said paragraph. For the language of paragraph (7) in effect for the 1963 and prior crops of wheat, see Pub. L. 74, 77th Cong., 55 Stat. 204, approved May 26, 1941, as amended by Pub. L. 87–128, 75 Stat. 297, approved August 8, 1961, and Pub. L. 87–801, 76 Stat. 910, approved October 11, 1962.

the wheat marketed from the farm or the proceeds thereof shall be jointly and severally liable for such penalty.

(8) [50] (Not applicable to wheat.)

(9) [50] (Applicable only through the 1946 crop.)

(10) [50] The provisions of this resolution are amendatory of and supplementary to the Act, and all provisions of law applicable in respect of marketing quotas and loans under such Act as so amended and supplemented shall be applicable, but nothing in this resolution shall be construed to amend or repeal sections 301(b)(6), 323(b) or 335(d) of the Act.

(11) [51] The persons liable for the payment or collection of the penalty on any amount of wheat shall be liable also for interest thereon at the rate of 6 per centum per annum from the date the penalty becomes due until the date of payment of such penalty.

(12) [52] If marketing quotas for wheat are not in effect for any marketing year, all previous marketing quotas applicable to wheat shall be terminated, effective as of the first day of such marketing year. Such termination shall not abate any penalty previously incurred by a producer or relieve any buyer of the duty to remit penalties previously collected by him. (7 U.S.C. 1330, 1340.)]

REFERENDUM

SEC. 336.[53] If a national marketing quota for wheat for one, two, or three marketing years is proclaimed, the Secretary shall, not later than August 1 of the calendar year in which such national marketing quota is proclaimed, conduct a referendum, by secret ballot, of farmers to determine whether they favor or oppose marketing quotas for the marketing year or years for which proclaimed. Any producer who has a farm acreage allotment shall be eligible to vote in any referendum held pursuant to this section, except that a producer who has a farm acreage allotment of less than fifteen acres shall not be eligible to vote unless the farm operator elected pursuant to section 335 to be subject to the farm marketing quota. The Secretary shall proclaim the results of any referendum held hereunder within thirty days after the date of such referendum, and if the Secretary determines that more than one-

[50] Original paragraph (7) was repealed by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962, which also renumbered paragraph (8) through (11) as paragraphs (7) through (10). The new paragraph (7) was further amended by said law which deleted the words, "corn or" and "as the case may be" from the first sentence and added the last sentence to said paragraph. For the language of paragraph (7) in effect for the 1963 and prior crops of wheat, see Pub. L. 74, 77th Cong., 55 Stat. 204, approved May 26, 1941, as amended by Pub. L. 87–128, 75 Stat. 297, approved August 8, 1961, and Pub. L. 87–801, 76 Stat. 910, approved October 11, 1962.

[51] A new paragraph (11) was added by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962.

[52] A new paragraph (12) was enacted by Pub. L. 87–703, 76 Stat. 625, approved September 27, 1962. For the language of paragraph (12) which was in effect for the 1963 and prior crops of wheat, see Pub. L. 384, 77th Cong., 55 Stat. 872, approved December 26, 1941.

[53] Section 336 enacted by Pub. L. 87–703, 76 Stat. 621, approved September 27, 1962. It was amended further by Pub. L. 88–297, 78 Stat. 179, approved April 11, 1964, which deleted the language, "not later than sixty days after such proclamation is published in the Federal Register" and inserted in lieu thereof the language, "not later than August 1 of the calendar year in which such national marketing quota is proclaimed". For the text of old section 336 which was in effect with respect to the 1963 and prior crops of wheat, see Pub. L. 430, 75th Cong., 52 Stat. 55, approved February 16, 1938, as amended by Pub. L. 897, 80th Cong., 62 Stat. 1256, approved July 3, 1948, Pub. L. 87–128, 75 Stat. 297, approved August 8, 1961, Pub. L. 87–104, 75 Stat. 220, approved July 25, 1961, and Pub. L. 540, 76 Stat. 170, approved July 19, 1962.

third of the farmers voting in the referendum voted against marketing quotas, the Secretary shall proclaim that marketing quotas will not be in effect with respect to the crop of wheat produced for harvest in the calendar year following the calendar year in which the referendum is held. If the Secretary determines that two-thirds or more of the farmers voting in a referendum approve marketing quotas for a period of two or three marketing years, no referendum shall be held for the subsequent year or years of such period. (7 U.S.C. 1336.)

ADJUSTMENT AND SUSPENSION OF QUOTA

SEC. 337.[54] * * *

TRANSFER OF QUOTAS

SEC. 338. Farm marketing quotas for wheat shall not be transferable, but, in accordance with regulations prescribed by the Secretary for such purpose, any farm marketing quota in excess of the supply of wheat for such farm for any marketing year may be allocated to other farms on which the acreage allotment has not been exceeded. (7 U.S.C. 1338.)

LAND USE [55]

[Sec. 339.(a) (1) as set out below is effective only with respect to the crops planted for harvest in 1964 and 1965.]

Sec. 339.(a) (1).[56] *As a condition of eligibility for wheat marketing certificates with respect to any farm, the producers on such farm shall be required to divert from the production of wheat to an approved conservation use an acreage of cropland on the farm equal to the number of acres determined by multiplying the farm acreage allotment by the diversion factor, and to participate in any program formulated under subsection (b) to the extent prescribed by the Secretary. Such diversion factor shall be determined by dividing the number of acres by which the national acreage allotment is reduced below fifty-five million acres by the number of acres in the national acreage allotment.*

[Sec. 339.(a) (1) as set out below is effective for the crops planted in 1966 and subsequent crop years.]

SEC. 339. (a) (1) [57] During any year in which marketing quotas for wheat are in effect, the producers on any farm (except a new farm receiving an allotment from the reserve for new farms) on which any crop is produced on acreage required to be diverted from the pro-

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[54] Section 337 was repealed by Pub. L. 87–703, 76 Stat. 622, approved September 27, 1962, effective with respect to the 1964 and subsequent crops of wheat. For the language of old section 337 which was in effect with respect to the 1963 crop of wheat, see Pub. L. 430, 75th Cong., 52 Stat. 55, approved February 16, 1938.

[55] See p. 287 for secs. 326, 327 and 328 of the Food and Agriculture Act of 1962 containing miscellaneous provisions applicable to the programs provided for in sec. 339.

[56] Sec. 339(a)(1) was amended by Pub. L. 88–297, 78 Stat. 179, approved April 11, 1964, effective only with respect to the crops planted in 1964 and 1965.

[57] This section 339(a)(1) was originally added by the Food and Agriculture Act of 1962, 76 Stat. 622, approved September 27, 1962. Sec. 339 is inapplicable to any farm receiving additional allotments under secs. 334 (h) and (i) and 335 of the Agricultural Adjustment Act of 1938, as amended. Sec. 385 of the Agricultural Adjustment Act of 1938, as amended, is applicable to payments made under sec. 339.

duction of wheat shall be subject to a penalty on such crop, in addition to any marketing quota penalty applicable to such crops, as provided in this subsection unless (1) the crop is designated by the Secretary as one which is not in surplus supply and will not be in surplus supply if it is permitted to be grown on the diverted acreage, or as one the production of which will not substantially impair the purpose of the requirements of this section, or (2) no wheat is produced on the farm, and the producers have not filed an agreement or a statement of intention to participate in the payment program formulated pursuant to subsection (b) of this section. The acreage required to be diverted from the production of wheat on the farm shall be an acreage of cropland equal to the number of acres determined by multiplying the farm acreage allotment by the diversion factor determined by dividing the number of acres by which the national acreage allotment is reduced below fifty-five million acres by the number of acres in the national acreage allotment. The actual production of any crop subject to penalty under this subsection shall be regarded as available for marketing and the penalty on such crop shall be computed on the actual acreage of such crop at the rate of 65 per centum of the parity price per bushel of wheat as of May 1 of the calendar year in which such crop is harvested, multiplied by the normal yield of wheat per acre established for the farm. Until the producers on any farm pay the penalty on such crop, the entire crop of wheat produced on the farm and any subsequent crop of wheat subject to marketing quotas in which the producer has an interest shall be subject to a lien in favor of the United States for the amount of the penalty. Each producer having an interest in the crop or crops on acreage diverted or required to be diverted from the production of wheat shall be jointly and severally liable for the entire amount of the penalty. The persons liable for the payment or collection of the penalty under this section shall be liable also for interest thereon at the rate of 6 per centum per annum from the date the penalty becomes due until the date of payment of such penalty.

(2) The Secretary may require that the acreage on any farm diverted from the production of wheat be land which was diverted from the production of wheat in the previous year, to the extent he determines that such requirement is necessary to effectuate the purposes of this subtitle.

(3) The Secretary may permit the diverted acreage to be grazed in accordance with regulations prescribed by the Secretary.

(b) [58] The Secretary is authorized to formulate and carry out a program with respect to the 1964 and 1965 crops of wheat under which, subject to such terms and conditions as he determines are desirable to effectuate the purposes of this section, payments may be made in amounts not in excess of 50 per centum of the estimated basic county support rate for wheat not accompanied by marketing certificates on the normal production of the acreage diverted taking into account the income objectives of the Act, determined by the Secretary to be fair

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[58] Pub. L. 88–297, 78 Stat. 179, approved April 11, 1964, amended subsec. (b) by inserting in the first sentence the words, "for wheat not accompanied by marketing certificates" after the words, "basic county support rate" and by adding a new sentence after the first sentence of subsec. (b) which begins with "Any producer" and ends with the words, "for the 1964 crop of wheat."

and reasonable with respect to acreage diverted pursuant to subsection (a) of this section. Any producer who complies with his 1964 farm acreage allotment for wheat and with the other requirements of the program shall be eligible to receive payments under the program for the 1964 crop of wheat. The Secretary may permit producers on any farm to divert from the production of wheat an acreage, in addition to the acreage diverted pursuant to subsection (a), equal to 20 per centum of the farm acreage allotment for wheat: *Provided*, That the producers on any farm may, at their election, divert such acreage in addition to the acreage diverted pursuant to subsection (a), as will bring the total acreage diverted on the farm to fifteen acres. Such program shall require (1) that the diverted acreage shall be devoted to conservation uses approved by the Secretary; (2) that the total acreage of cropland on the farm devoted to soil-conserving uses, including summer fallow and idle land but excluding the acreage diverted as provided above, shall be not less than the total average acreage of cropland devoted to soil-conserving uses including summer fallow and idle land on the farm during a representative period, as determined by the Secretary, adjusted to the extent the Secretary determines appropriate for (i) abnormal weather conditions or other factors affecting production, (ii) established crop-rotation practices on the farm, (iii) participation in other Federal farm programs, (iv) unusually high percentage of land on the farm devoted to conserving uses, and (v) other factors which the Secretary determines should be considered for the purpose of establishing a fair and equitable soil-conserving acreage for the farm; and (3) that the producer shall not knowingly exceed (i) any farm acreage allotment in effect for any commodity produced on the farm, and (ii) except as the Secretary may by regulations prescribe, with the farm acreage allotments on any other farm for any crop in which the producer has a share: *Provided*, That no producer shall be deemed to have exceeded a farm acreage allotment for wheat if the entire amount of the farm marketing excess is delivered to the Secretary or stored in accordance with applicable regulations to avoid or postpone payment of the penalty: *And provided further*, That no producer shall be deemed to have exceeded a farm acreage allotment for any crop of wheat if the farm is exempt from the farm marketing quota for such crop under section 335. The producers on a new farm shall not be eligible for payments hereunder. The Secretary shall provide for the sharing of payment among producers on the farm on a fair and equitable basis. Payments may be made in cash or in wheat.

(c) The Secretary may provide for adjusting any payment on account of failure to comply with the terms and conditions of the land-use program formulated under subsection (b) of this section.

(d) Not to exceed 50 per centum of any payment to producers under subsection (b) of this section may be made in advance of determination of performance.

(e) The Secretary may permit the diverted acreage to be devoted to the production of guar, sesame, safflower, sunflower, castor beans, and flax, when such crops are not in surplus supply and will not be in surplus supply if permitted to be grown on the diverted acreage, subject to the condition that payment with respect to diverted acreage

devoted to any such crop shall be at a rate determined by the Secretary to be fair and reasonable taking into consideration the use of such acreage for the production of such crops: *Provided*, That in no event shall the payment exceed one-half the rate which would otherwise be applicable if such acreage were devoted to conservation uses and no price support shall be made available for the production of any such crop on such diverted acreage.

(f) The program formulated pursuant to subsection (b) of this section may include such terms and conditions, including provision for the control of erosion, in addition to those specifically provided for herein, as the Secretary determines are desirable to effectuate the purposes of this section.

(g) The Secretary is authorized to promulgate such regulations as may be desirable to carry out the provisions of this section.

(h)[59] The Commodity Credit Corporation is authorized to utilize its capital funds and other assets for the purpose of making the payments authorized in this section and to pay administrative expenses necessary in carrying out this section during the period ending June 30, 1965. There is authorized to be appropriated such amounts as may be necessary thereafter to pay such administrative expenses. (7 U.S.C. 1339.)

PART IV—MARKETING QUOTAS—COTTON

LEGISLATIVE FINDINGS

SEC. 341. American cotton is a basic source of clothing and industrial products used by every person in the United States and by substantial numbers of people in foreign countries. American cotton is sold on a world-wide market and moves from the places of production almost entirely in interstate and foreign commerce to processing establishments located throughout the world at places outside the State where the cotton is produced.

Fluctuations in supplies of cotton and the marketing of excessive supplies of cotton in interstate and foreign commerce disrupt the orderly marketing of cotton in such commerce with consequent injury to and destruction of such commerce. Excessive supplies of cotton directly and materially affect the volume of cotton moving in interstate and foreign commerce and cause disparity in prices of cotton and industrial products moving in interstate and foreign commerce with consequent diminution of the volume of such commerce in industrial products.

The conditions affecting the production and marketing of cotton are such that, without Federal assistance, farmers, individually or in cooperation, cannot effectively prevent the recurrence of excessive supplies of cotton and fluctuations in supplies, cannot prevent indiscriminate dumping of excessive supplies on the Nation-wide and foreign markets, cannot maintain normal carry-overs of cotton, and cannot provide for the orderly marketing of cotton in interstate and foreign commerce.

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[59] Subsection (h) was amended by Pub. L. 88–297, 78 Stat. 179, approved April 11, 1964, by striking out the date, "June 30, 1963" and substituting the date, "June 30, 1965".

It is in the interest of the general welfare that interstate and foreign commerce in cotton be protected from the burdens caused by the marketing of excessive supplies of cotton in such commerce, that a supply of cotton be maintained which is adequate to meet domestic consumption and export requirements in years of drought, flood, and other adverse conditions as well as in years of plenty, and that the soil resources of the Nation be not wasted in the production of excessive supplies of cotton.

The provisions of this part affording a cooperative plan to cotton producers are necessary and appropriate to prevent the burdens on interstate and foreign commerce caused by the marketing in such commerce of excessive supplies, and to promote, foster, and maintain an orderly flow of an adequate supply of cotton in such commerce. (7 U.S.C. 1341.)

NATIONAL MARKETING QUOTA

SEC. 342. Whenever during any calendar year the Secretary determines that the total supply of cotton for the marketing year beginning in such calendar year will exceed the normal supply for such marketing year, the Secretary shall proclaim such fact and a national marketing quota shall be in effect for the crop of cotton produced in the next calendar year. The Secretary shall also determine and specify in such proclamation the amount of the national marketing quota in terms of the number of bales of cotton (standard bales of five hundred pounds gross weight) adequate, together with (1) the estimated carry-over at the beginning of the marketing year which begins in the next calendar year and (2) the estimated imports during such marketing year, to make available a normal supply of cotton: *Provided*, That beginning with the 1961 crop, the national marketing quota shall be not less than a number of bales equal to the estimated domestic consumption and estimated exports (less estimated imports) for the marketing year for which the quota is proclaimed, except that the Secretary shall make such adjustments in the amount of such quota as he determines necessary after taking into consideration the estimated stocks of cotton in the United States (including the qualities of such stocks) and stocks in foreign countries which would be available for the marketing year for which the quota is being proclaimed if no adjustment of such quota is made hereunder, to assure the maintenance of adequate but not excessive stocks in the United States to provide a continuous and stable supply of the different qualities of cotton needed in the United States and in foreign cotton consuming countries, and for purposes of national security; but the Secretary, in making such adjustments, may not reduce the national marketing quota for any year below (i) one million bales less than the estimated domestic consumption and estimated exports for the marketing year for which such quota is being proclaimed, or (ii) ten million bales, whichever is larger. Such proclamation shall be made not later than October 15 of the calendar year in which such determination is made. * * * [60] Notwithstanding any other provision of this Act, the

[60] A proviso which was effective only with respect to the 1957 and 1958 crops of cotton has been deleted.

national marketing quota for upland cotton for 1959 and subsequent years shall be not less than the number of bales required to provide a national acreage allotment for each such year of sixteen million acres. (7 U.S.C. 1342.)

REFERENDUM

SEC. 343. Not later than December 15 following the issuance of the marketing quota proclamation provided for in section 342, the Secretary shall conduct a referendum, by secret ballot, of farmers engaged in the production of cotton in the calendar year in which the referendum is held, to determine whether such farmers are in favor of or opposed to the quota so proclaimed: *Provided*, That * * * [61] If more than one-third of the farmers voting in the referendum oppose the national marketing quota, such quota shall become ineffective upon proclamation of the results of the referendum. The Secretary shall proclaim the results of any referendum held hereunder within thirty days after the date of such referendum. (7 U.S.C. 1343).

ACREAGE ALLOTMENTS

SEC. 344. (a) Whenever a national marketing quota is proclaimed under section 342, the Secretary shall determine and proclaim a national acreage allotment for the crop of cotton to be produced in the next calendar year. The national acreage allotment for cotton shall be that acreage, based upon the national average yield per acre of cotton for the four years immediately preceding the calendar year in which the national marketing quota is proclaimed, required to make available from such crop an amount of cotton equal to the national marketing quota. (7 U.S.C. 1344(a).)

(b) The national acreage allotment for cotton for 1953 and subsequent years shall be apportioned to the States on the basis of the acreage planted to cotton (including the acreage regarded as having been planted to cotton under the provisions of Public Law 12, Seventy-ninth Congress) during the five calendar years immediately preceding the calendar year in which the national marketing quota is proclaimed, with adjustments for abnormal weather conditions during such period: *Provided*, That * * * [62]: *Provided*, That there is hereby established a national acreage reserve consisting of three hundred and ten thousand acres which shall be in addition to the national acreage allotment; and such reserve shall be apportioned to the States on the basis of their needs for additional acreage for establishing minimum farm allotments under subsection (f)(1), as determined by the Secretary without regard to State and county acreage reserves (except that the amount apportioned to Nevada shall be one thousand acres). For the 1960 and succeeding crops of cotton, the needs of States (other than Nevada) for such additional acreage for such purpose may be estimated by the Secretary, after taking into consideration such needs as determined or estimated for the preceding crop of cotton and the size of the national acreage allotment for such crop.

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[61] A proviso which was effective only with respect to the 1950 crop of cotton has been deleted.

[62] A proviso which was effective only with respect to the 1957 and 1958 crops of cotton has been deleted.

The additional acreage so apportioned to the State shall be apportioned to the counties on the basis of the needs of the counties for such additional acreage for such purpose, and added to the county acreage allotment for apportionment to farms pursuant to subsection (f) of this section (except that no part of such additional acreage shall be used to increase the county reserve above 15 per centum of the county allotment determined without regard to such additional acreage). Additional acreage apportioned to a State for any year under the foregoing proviso shall not be taken into account in establishing future State acreage allotments. Needs for additional acreage under the foregoing provisions and under the last proviso in subsection (e) shall be determined or estimated as though allotments were first computed without regard to subsection (f)(1). (7 U.S.C. 1344(b).)

(c) (Applicable only to the 1950 and 1951 crops of cotton.)

(d) (Applicable only to the 1952 crop of cotton.)

(e) The State acreage allotment for cotton shall be apportioned to counties on the same basis as to years and conditions as is applicable to the State under subsections (b), (c), and (d) of this section: *Provided*, That the State committee may reserve not to exceed 10 per centum of its State acreage allotment (15 per centum if the State's 1948 planted acreage was in excess of one million acres and less than half its 1943 allotment) which shall be used to make adjustments in county allotments for trends in acreage, for counties adversely affected by abnormal conditions affecting plantings, or for small or new farms, or to correct inequities in farm allotments and to prevent hardship: *Provided further*, That * * *[63]: *Provided further*, That if the additional acreage allocated to a State under the proviso in subsection (b) is less than the requirements as determined or estimated by the Secretary for establishing minimum farm allotments for the State under subsection (f)(1), the acreage reserved under this subsection shall not be less than the smaller of (1) the remaining acreage so determined or estimated to be required for establishing minimum farm allotments or (2) 3 per centum of the State acreage allotment; and the acreage which is required to be reserved under this proviso shall be allocated to counties on the basis of their needs for additional acreage for establishing minimum farm allotments under subsection (f)(1), and added to the county acreage allotment for apportionment to farms pursuant to subsection (f) of this section (except that no part of such additional acreage shall be used to increase the county reserve above 15 per centum of the county allotment determined without regard to such additional acreages). (7 U.S.C. 1344(e).)

(f) The county acreage allotment, less not to exceed the percentage provided for in paragraph (3) of this subsection shall be apportioned to farms on which cotton has been planted (or regarded as having been planted under the provisions of Public Law 12, Seventy-ninth Congress) in any one of the three years immediately preceding the year for which such allotment is determined on the following basis:

(1) Insofar as such acreage is available, there shall be allotted the smaller of the following: (A) ten acres; or (B) the acreage allotment established for the farm for the 1958 crop.

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[63] A proviso which was effective only with respect to the 1957 and 1958 crops of cotton was deleted.

(2) The remainder shall be allotted to farms other than farms to which an allotment has been made under paragraph (1) (B) so that the allotment to each farm under this paragraph together with the amount of the allotment to such farm under paragraph (1) (A) shall be a prescribed percentage (which percentage shall be the same for all such farms in the county or administrative area) of the acreage, during the preceding year, on the farm which is tilled annually or in regular rotation, excluding from such acreages the acres devoted to the production of sugarcane for sugar; sugar beets for sugar; wheat, tobacco, or rice for market; peanuts picked and threshed; wheat or rice for feeding to livestock for market; or lands determined to be devoted primarily to orchards or vineyards, and nonirrigated lands in irrigated areas: *Provided, however*, That if a farm would be allotted under this paragraph an acreage together with the amount of the allotment to such farm under paragraph (1) (A) in excess of the largest acreage planted (and regarded as planted under Public Law 12, Seventy-ninth Congress) to cotton during any of the preceding three years, the acreage allotment for such farm shall not exceed such largest acreage so planted (and regarded as planted under Public Law 12, Seventy-ninth Congress) in any such year.

(3) The county committee may reserve not in excess of 15 per centum of the county allotment * * * which, in addition to the acreage made available under the proviso in subsection (e), shall be used for (A) establishing allotments for farms on which cotton was not planted (or regarded as planted under Public Law 12, Seventy-ninth Congress) during any of the three calendar years immediately preceding the year for which the allotment is made, on the basis of land, labor, and equipment available for the production of cotton, crop-rotation practices, and the soil and other physical facilities affecting the production of cotton; and (B) making adjustments of the farm acreage allotments established under paragraphs (1) and (2) of this subsection so as to establish allotments which are fair and reasonable in relation to the factors set forth in this paragraph and abnormal conditions of production on such farms, or in making adjustments in farm acreage allotments to correct inequities and to prevent hardship: *Provided*, That not less than 20 per centum of the acreage reserved under this subsection shall, to the extent required, be allotted upon such basis as the Secretary deems fair and reasonable to farms (other than farms to which an allotment has been made under subsection (f) (1) (B), if any, to which an allotment of not exceeding fifteen acres may be made under other provisions of this subsection.

(4) (Applicable only to the 1950 crop of cotton.)

(5) (Applicable only to the 1950 crop of cotton.)

(6) Notwithstanding the provisions of paragraph (2) of the subsection, if the county committee recommends such action and the Secretary determines that such action will result in a more equitable distribution of the county allotment among farms in the county, the remainder of the county acreage allotment (after

making allotments as provided in paragraph (1) of this subsection) shall be allotted to farms other than farms to which an allotment has been made under paragraph (1)(B) of this subsection so that the allotment to each farm under this paragraph together with the amount of the allotment of such farm under paragraph (1)(A) of this subsection shall be a prescribed percentage (which percentage shall be the same for all such farms in the county) of the average acreage planted to cotton on the farm during the three years immediately preceding the year for which such allotment is determined, adjusted as may be necessary for abnormal conditions affecting plantings during such three-year period: *Provided*, That the county committee may in its discretion limit any farm acreage allotment established under the provisions of this paragraph for any year to an acreage not in excess of 50 per centum of the cropland on the farm, as determined pursuant to the provisions of paragraph (2) of this subsection: *Provided further*, That any part of the county acreage allotment not apportioned under this paragraph by reason of the initial application of such 50 per centum limitation shall be added to the county acreage reserve under paragraph (3) of this subsection and shall be available for the purposes specified therein. If the county acreage allotment is apportioned among the farms of the county in accordance with the provisions of this paragraph, the acreage reserved under paragraph (3) of this subsection may be used to make adjustments so as to establish allotments which are fair and reasonable to farms receiving allotments under this paragraph in relation to the factors set forth in paragraph (3).

(7)(A) In the event that any farm acreage allotment is less than that prescribed by paragraph (1), such acreage allotment shall be increased to the acreage prescribed by paragraph (1). The additional acreage required to be alloted to farms under this paragraph shall be in addition to the county, State, and national acreage allotments and the production from such acreage shall be in addition to the national marketing quota.

(B) Notwithstanding any other provision of law—

(i) the acreage by which any farm acreage allotment for 1959 or any subsequent crop established under paragraph (1) exceeds the acreage which would have been allotted to such farm if its allotment had been computed on the basis of the same percentage factor applied to other farms in the county under paragraph (2), (6), or (8) shall not be taken into account in establishing the acreage allotment for such farm for any crop for which acreage is allotted to such farm under paragraph (2), (6), or (8); and acreage shall be allotted under paragraph (2), (6), or (8) to farms which did not receive 1958 crop allotments in excess of ten acres if and only if the Secretary determines (after considering the allotments to other farms in the county for such crop compared with their 1958 allotments and other relevant factors) that equity and justice require the allotment of additional acreage to such farm under paragraph (2), (6), or (8),

(ii) the acreage by which any county acreage allotment for 1959 or any subsequent crop is increased from the national or State reserve on the basis of its needs for additional acreage for establishing minimum farm allotments shall not be taken into account in establishing future county acreage allotments, and

(iii) the additional acreage allotted pursuant to subparagraph (A) of this paragraph (7) shall not be taken into account in establishing future State, county, or farm acreage allotments.

(8) Notwithstanding the foregoing provisions of paragraphs (2) and (6) of this subsection, the Secretary shall, if allotments were in effect the preceding year, provide for the county acreage allotment for the 1959 and succeeding crops of cotton, less the acreage reserved under paragraph (3) of this subsection, to be apportioned to farms on which cotton has been planted in any one of the three years immediately preceding the year for which such allotment is determined, on the basis of the farm acreage allotment for the year immediately preceding the year for which such apportionment is made, adjusted as may be necessary (i) for any change in the acreage of cropland available for the production of cotton, or (ii) to meet the requirements of any provision (other than those contained in pargraphs (2) and (6)) with respect to the counting of acreage for history purposes: *Provided*, That, beginning with allotments established for the 1961 crop of cotton, if the acreage actually planted (or regarded as planted under the Soil Bank Act, the Great Plains program, and the release and reapportionment provisions of subsection (m)(2) of this section) to cotton on the farm in the preceding year was less than 75 per centum of the farm allotment for such year or, in the case of a farm which qualified for price support on the crop produced in such year under section 103(b) of the Agricultural Act of 1949, as amended, 75 per centum of the farm domestic allotment established under section 350 for such year, whichever is smaller,[64] in lieu of using such allotment as the farm base as provided in this paragraph, the base shall be the average of (1) the cotton acreage for the farm for the preceding year as determined for purposes of this proviso and (2) the allotment established for the farm pursuant to the provisions of this subsection (f) for such preceding year; and the 1958 allotment used for establishing the minimum farm allotment under paragraph (1) of this subsection (f) shall be adjusted to the average acreage so determined. The base for a farm shall not be adjusted as provided in this paragraph if the county committee determines that failure to plant at least 75 per centum of the farm allotment was due to conditions beyond the control of producers on the farm. The Secretary shall establish limitations to prevent allocations of allotment to farms not affected by the

[64] Pub. L. 88–297, 78 Stat. 177, approved April 11, 1964, amended the proviso in subparagraph (8) by adding the language: "or, in the case of a farm which qualified for price support on the crop produced in such year under section 103(b) of the Agricultural Adjustment Act of 1949, as amended, 75 per centum of the farm domestic allotment established under section 350 for such year, whichever is smaller".

foregoing proviso, which would be excessive on the basis of the cropland, past cotton acreage, allotments for other commodities, and good soil conservation practices on such farms. (7 U.S.C. 1344(f).)

(g) Notwithstanding the foregoing provisions of this section—

(1) State, county, and farm acreage allotments and yields for cotton shall be established in conformity with Public Law 28, Eighty-first Congress.

(2) In apportioning the county allotment among the farms within the county, the Secretary, through the local committees, shall take into consideration different conditions within separate administrative areas within a county if any exist, including types, kinds, and productivity of the soil so as to prevent discrimination among the admnistrative areas of the county.

(3)[65] * * *

(h)[66] * * *

(i) Notwithstanding any other provision of this Act, any acreage planted to cotton in excess of the farm acreage allotment shall not be taken into account in establishing State, county, and farm acreage allotments. Notwithstanding any other provision of this Act, beginning with the 1960 crop the planting of cotton on a farm in any of the immediately preceding three years that allotments were in effect but no allotment was established for such farm for any year of such three-year period shall not make the farm eligible for an allotment as an old farm under subsection (f) of this section: *Provided, however,* That by reason of such planting the farm need not be considered as ineligible for a new farm allotment under subsection (f)(3) of this section. (7 U.S.C. 1344(i).)

(j) Notwithstanding any other provision of this Act, State and county committees shall make available for inspection by owners or operators of farms receiving cotton acreage allotments all records pertaining to cotton acreage allotments and marketing quotas. (7 U.S.C. 1344(j).)

(k) Notwithstanding any other provision of this section except subsection (g)(1), there shall be allotted to each State for which an allotment is made under this section not less than the smaller of (A) four thousand acres or (B) the highest acreage planted to cotton in any one of the three calendar years immediately preceding the year for which the allotment is made. (7 U.S.C. 1344(k).)

(l) [This subsection relating to war crops under Public Law 12, Seventy-ninth Congress, does not apply to the 1955 and succeeding crops of cotton. (7 U.S.C. 1344(1).)]

(m) Notwithstanding any other provision of law—

(1) (Applicable only to 1954 crop of cotton.)

(2) Any part of any farm cotton acreage allotment on which cotton will not be planted and which is voluntarily surrendered to the county committee shall be deducted from the allotment to such farm and may be reapportioned by the county committee to other farms in the same county receiving allotments in amounts deter-

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[65] Sec. 344(g)(3) was repealed by Pub. L. 86–172, 73 Stat. 394, approved August 18, 1959.
[66] Repealed by Pub. L. 85–835, 72 Stat. 996, approved August 28, 1958.

mined by the county committee to be fair and reasonable on the basis of past acreage of cotton, land, labor, equipment available for the production of cotton, crop rotation practices, and soil and other physical facilities affecting the production of cotton. If all of the allotted acreage voluntarily surrendered is not needed in the county, the county committee may surrender the excess acreage to the State committee to be used for the same purposes as the State acreage reserve under subsection (e) of this section. Any allotment released under this provision shall be regarded for the purposes of establishing future allotments as having been planted on the farm and in the county where the release was made rather than on the farm and in the county to which the allotment was transferred, except that this shall not operate to make the farm from which the allotment was transferred eligible for an allotment as having cotton planted thereon during the three-year base period: *Provided*, That notwithstanding any other provisions of law, any part of any farm acreage allotment may be permanently released in writing to the county committee by the owner and operator of the farm, and reapportioned as provided herein. Acreage release under this paragraph shall be credited to the State in determining future allotments. The provisions of this paragraph shall apply also to extra long staple cotton covered by section 347 of this Act. (7 U.S.C. 1344(m).)

(3) (Applicable only to 1954 crop of cotton.)

(n)[67] Notwithstanding any other provision of this Act, if the Secretary determines for any year that because of a natural disaster a portion of the farm cotton acreage allotments in a county cannot be timely planted or replanted in such year, he may authorize for such year the transfer of all or a part of the cotton acreage allotment for any farm in the county so affected to another farm in the county or in an adjoining county on which one or more of the producers on the farm from which the transfer is to be made will be engaged in the production of cotton and will share in the proceeds thereof, in accordance with such regulations as the Secretary may prescribe. Any farm allotment transferred under this paragraph shall be deemed to be released acreage for the purposes of acreage history credits under sections 344(f)(8), 344(m)(2), and 377 of this Act: *Provided*, That, notwithstanding the provisions of section 344(m)(2) of this Act, the transfer of any farm allotment under this subsection for any year shall operate to make the farm from which the allotment was transferred eligible for an allotment as having cotton planted thereon during the three-year base period. (7 U.S.C. 1344(n).)

FARM MARKETING QUOTAS

SEC. 345. The farm marketing quota for any crop of cotton shall be the actual production of the acreage planted to cotton on the farm less the farm marketing excess. The farm marketing excess shall be the normal production of that acreage planted to cotton on the farm

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[67] Pub. L. 88–12, 77 Stat. 13, approved April 26, 1963, amended subsection (n) by adding a proviso thereto and by making it applicable to the 1963 crop of cotton. Pub. L. 88–297, 78 Stat. 177, approved April 11, 1964, amended subsection (n) to make it applicable to any crop year.

which is in excess of the farm acreage allotment: *Provided*, That such farm marketing excess shall not be larger than the amount by which the actual production of cotton on the farm exceeds the normal production of the farm acreage allotment, if the producer establishes such actual production to the satisfaction of the Secretary. (7 U.S.C. 1345.)

PENALTIES

SEC. 346 (a) Whenever farm marketing quotas are in effect with respect to any crop of cotton, the producer shall be subject to a penalty on the farm marketing excess at a rate per pound equal to 50 per centum of the parity price per pound for cotton as of June 15 of the calendar year in which such crop is produced. (7 U.S.C. 1346(a).)

(b) The farm marketing excess of cotton shall be regarded as available for marketing and the amount of penalty shall be computed upon the normal production of the acreage on the farm planted to cotton in excess of the farm acreage allotment. If a downward adjustment in the amount of the farm marketing excess is made pursuant to the proviso in section 345, the difference between the amount of the penalty computed upon the farm marketing excess before such adjustment and as computed upon the adjusted farm marketing excess shall be returned to or allowed the producer. (7 U.S.C. 1346(b).)

(c) The person liable for payment or collection of the penalty shall be liable also for interest thereon at the rate of 6 per centum per annum from the date the penalty becomes due until the date of payment of such penalty. (7 U.S.C. 1346(c).)

(d) Until the penalty on the farm marketing excess is paid, all cotton produced on the farm and marketed by the producers shall be subject to the penalty provided by this section and a lien on the entire crop of cotton produced on the farm shall be in effect in favor of the United States. (7 U.S.C. 1346(d).)

LONG STAPLE COTTON

SEC. 347. (a) Except as otherwise provided by this section, the provisions of this part shall not apply to extra long staple cotton which is produced from pure strain varieties of the Barbadense species, or any hybrid thereof, or other similar types of extra long staple cotton designated by the Secretary having characteristics needed for various end uses for which American upland cotton is not suitable, and grown in irrigated cotton-growing regions of the United States designated by the Secretary or other areas designated by the Secretary as suitable for the production of such varieties or types. (7 U.S.C. 1347(a).)

(b)[68] Whenever during any calendar year, not later than October 15, the Secretary determines that the total supply of cotton described in subsection (a) for the marketing year beginning in such calendar year will exceed the normal supply thereof for such marketing year by more than 8 per centum, the Secretary shall proclaim such fact

[68] The last proviso in Section 347(b) was added by Pub. L. 86-566, 74 Stat. 295, approved June 30, 1960.

and a national marketing quota shall be in effect for the crop of such cotton produced in the next calendar year. The Secretary shall also determine and specify in such proclamation the amount of the national marketing quota in terms of the quantity of cotton described in subsection (a) adequate to make available a normal supply of cotton, taking into account (1) the estimated carry-over at the beginning of the marketing year which begins in the next calendar year, and (2) the estimated imports during such marketing year: *Provided*, That beginning with the 1961 crop of extra long staple cotton, such national marketing quota shall be an amount equal to (1) the estimated domestic consumption plus exports for the marketing year which begins in the next calendar year, less (2) the estimated imports, plus (3) such additional number of bales, if any, as the Secretary determines is necessary to assure adequate working stocks in trade channels until cotton from the next crop becomes readily available without resort to Commodity Credit Corporation stocks. The national marketing quota for cotton described in subsection (a) for any year shall not be less than the larger of thirty thousand bales or a number of bales equal to 30 per centum of the estimated domestic consumption plus exports of such cotton for the marketing year beginning in the calendar year in which such quota is proclaimed: *Provided, however*, That the national marketing quota for 1960 and 1961 crops of such cotton shall be not less than 90 per centum of the 1959 marketing quota for such cotton.[69] (7 U.S.C. 1347(b).)

(c) All provisions of this Act, except section 342, subsection (h), (k), and (l) of section 344, the parenthetical provisions relating to acreages regarded as having been planted to cotton, and the provisions relating to minimum small farm allotments, shall, insofar as applicable, apply to marketing quotas and acreage allotments authorized by this section: *Provided*, That the applicable penalty rate for such cotton under section 346 shall be the higher of 50 per centum of the parity price or 50 per centum of the support price for extra long staple cotton as of the date specified therein. (7 U.S.C. 1347(c).)

(d) Unless marketing quotas are in effect under subsection (b) of this section, the penalty provisions of section 346 shall not apply to any cotton the staple of which is one and one-half inches or more in length. (7 U.S.C. 1347(d).)

(e) The exemptions authorized by subsections (a) and (d) of this section shall not apply unless (1) the cotton is ginned on a roller-type gin or (2) the Secretary authorizes the cotton to be ginned on another type gin for experimental purposes or to prevent loss of the cotton due to frost or other adverse condition. (7 U.S.C. 1347(e).)

COTTON EQUALIZATION PAYMENTS

SEC. 348.[70] In order to maintain and expand domestic consumption of upland cotton produced in the United States and to prevent discrimination against the domestic users of such cotton, notwithstanding

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[69] The exclusion of extra long staple cotton from the determination of the national marketing quota is required under Pub. L. 87–548, 76 Stat. 218, approved July 25, 1962, and Pub. L, 88–638, 78 Stat. 1038, approved October 8, 1964, which can be found on pages 185 and 186, respectively.

[70] New section 348 added by Pub. L. 88–297, 78 Stat. 173, approved April 11, 1964.

any other provision of law, the Commodity Credit Corporation, under such rules and regulations as the Secretary may prescribe, is authorized and directed for the period beginning with the date of enactment of this section and ending July 31, 1966, to make payments through the issuance of payment-in-kind certificates to persons other than producers in such amounts and subject to such terms and conditions as the Secretary determines will eliminate inequities due to differences in the cost of raw cotton between domestic and foreign users of such cotton, including such payments as may be necessary to make raw cotton in inventory on the date of enactment of this section available for consumption at prices consistent with the purposes of this section: *Provided*, That for the period beginning August 1 of the marketing year for the first crop for which price support is made available under section 103(b) of the Agriculture Act of 1949, as amended, and ending July 31, 1966, such payments shall be made in an amount which will make upland cotton produced in the United States available for domestic use at a price which is not in excess of the price at which such cotton is made available for export. (7 U.S.C. 1348.)

EXPORT MARKET ACREAGE

SEC. 349.[71] (a) The acreage allotment established under the provisions of section 344 of this Act for each farm for the 1964 crop may be supplemented by the Secretary by an acreage equal to such percentage, but not more than 10 per centum, of such acreage allotment as he determines will not increase the carryover of upland cotton at the beginning of the marketing year for the next succeeding crop above one million bales less than the carryover on the same date one year earlier, if the carryover on such earlier date exceeds eight million bales. For the 1965 crop, the Secretary may, after such hearing and investigation as he finds necessary, announce an export market acreage which he finds will not increase the carryover of upland cotton at the beginning of the marketing year for the next succeeding crop above one million bales less than the carryover on the same date one year earlier, if the carryover on such earlier date exceeds eight million bales. Such export market acreage shall be apportioned to the States on the basis of the State acreage allotments established under section 344 and apportioned by the States to farms receiving allotments under section 344, pursuant to regulations issued by the Secretary, after considering applications for such acreage filed with the county committee of the county in which the farm is located. The "export market acreage" on any farm shall be the number of acres, not exceeding the maximum export market acreage for the farm established pursuant to this subsection, by which the acreage planted to cotton on the farm exceeds the farm acreage allotment. For purposes of sections 345 and 374 of this Act and the provisions of any law requiring compliance with a farm acreage allotment as a condition of eligibility for price support or payments under any farm program, the farm acreage allotment for farms with export market acreage shall be the sum of the farm acreage allotment established under section 344 and the maximum export

[71] New section 349 added by Pub. L. 88-297, 78 Stat. 175, approved April 11, 1964.

market acreage. Export market acreage shall be in addition to the county, State, and National acreage allotments and shall not be taken into account in establishing future State, county, and farm acreage allotments. The provisions of this section shall not apply to extra-long-staple cotton or to any farm which receives price support under section 103(b) of the Agricultural Act of 1949, as amended. (7 U.S.C. 1349(a).)

(b) The producers on any farm on which there is export market acreage or the purchasers of cotton produced thereon shall, under regulations issued by the Secretary, furnish a bond or other undertaking prescribed by the Secretary providing for the exportation, without benefit of any Government cotton export subsidy and within such period of time as the Secretary may specify, of a quantity of cotton produced on the farm equal to the average yield for the farm multiplied by the export market acreage as determined pursuant to regulations issued by the Secretary. The bond or other undertaking given pursuant to this section shall provide that, upon failure to comply with the terms and conditions thereof, the person furnishing such bond or other undertaking shall be liable for liquidated damages in an amount which the Secretary determines and specifies in such undertaking will approximate the amount payable on excess cotton under section 346(a). The Secretary may, in lieu of the furnishing of a bond or other undertaking, provide for the payment of an amount equal to that which would be payable as liquidated damages under such bond or other undertaking. If such bond or other undertaking is not furnished, or if payment in lieu thereof is not made as provided herein, at such time and in the manner required by regulations of the Secretary, or if the acreage planted to cotton on the farm exceeds the farm acreage allotment established under the provisions of section 344 by more than the maximum export market acreage, the farm acreage allotment shall be the acreage so established under section 344. Amounts collected by the Secretary under this section shall be remitted to the Commodity Credit Corporation and used by the Corporation to defray costs of encouraging export sales of cotton under section 203 of the Agricultural Act of 1956, as amended. (7 U.S.C. 1349(b).)

DOMESTIC ACREAGE ALLOTMENTS

SEC. 350.[72] In order to provide producers with a choice program of reduced acreage and higher price support, the Secretary shall establish for each farm for the 1964 and 1965 crops of upland cotton a farm domestic allotment in acres. The farm domestic allotment shall be the percentage which the national domestic allotment is of the national acreage allotment established under section 344(a) applied as a percentage of the smaller of (1) the farm acreage allotment established under section 344, or (2) the higher acreage actually planted or regarded as planted on the farm (excluding acreage regarded as planted under sections 344(m)(2) and 377) in the two years preceding the year for which such allotment is established: *Provided*, That any farm planting 90 per centum or more of the allotment shall, for the

[72] New section 350 added by Pub. L. 88–297, 78 Stat. 175, approved April 11, 1964.

purpose of (2) above, be considered as having planted the entire farm allotment: *Provided further*, That, except for farms the acreage allotments of which are reduced under section 344(m), the farm domestic allotment shall not be less than the smaller of 15 acres or the farm acreage allotment established under section 344, but this proviso shall be applicable to the 1964 crop without regard to the exception stated herein. The national domestic acreage allotment for any crop shall be that acreage, based upon the national average yield per acre of cotton for the four years immediately preceding the calendar year in which the national acreage allotment is proclaimed, required to make available from such crop an amount of upland cotton equal to the estimated domestic consumption for the marketing year for such crop. The Secretary shall proclaim the national domestic acreage allotment for the 1964 crop not later than April 1, 1964, and for each subsequent crop not later than December 15 of the calendar year preceding the year in which the crop is to be produced. (7 U.S.C. 1350.)

Part V—Marketing Quotas—Rice

Legislative findings

Sec. 351. (a) The marketing of rice constitutes one of the great basic industries of the United States with ramifying activities which directly affect interstate and foreign commerce at every point, and stable conditions therein are necessary to the general welfare. Rice produced for market is sold on a Nation-wide market, and, with its products, moves almost wholly in interstate and foreign commerce from the producer to the ultimate consumer. The farmers producing such commodity are subject in their operations to uncontrollable natural causes, in many cases such farmers carry on their farming operations on borrowed money or leased lands, and are not so situated as to be able to organize effectively, as can labor and industry, through unions and corporations enjoying Government sanction and protection for joint economic action. For these reasons, among others, the farmers are unable without Federal assistance to control effectively the orderly marketing of such commodity with the result that abnormally excessive supplies thereof are produced and dumped indiscriminately on the Nation-wide market. (7 U.S.C. 1351(a).)

(b) The disorderly marketing of such abnormally excessive supplies affects, burdens, and obstructs interstate and foreign commerce by (1) materially affecting the volume of such commodity marketed therein, (2) disrupting the orderly marketing of such commodity therein, (3) reducing the prices for such commodity with consequent injury and destruction of such commerce in such commodity, and (4) causing a disparity between the prices for such commodity in interstate and foreign commerce and industrial products therein, with a consequent diminution of the volume of interstate and foreign commerce in industrial products. (7 U.S.C. 1351(b).)

(c) Whenever an abnormally excessive supply of rice exists, the marketing of such commodity by the producers thereof directly and substantially affects interstate and foreign commerce in such commodity and its products, and the operation of the provisions of this

part becomes necessary and appropriate in order to promote, foster, and maintain an orderly flow of such supply in interstate and foreign commerce. (7 U.S.C. 1351(c).)

NATIONAL ACREAGE ALLOTMENT

SEC. 352. The national acreage allotment of rice for any calendar year shall be that acreage which the Secretary determines will, on the basis of the national average yield of rice for the five calendar years immediately preceding the calendar year for which such national average yield is determined, produce an amount of rice adequate, together with the estimated carry-over from the marketing year ending in such calendar year, to make available a supply for the marketing year commencing in such calendar year not less than the normal supply: *Provided, however*, That for 1956 no national acreage allotment shall be established which is less than 85 per centum of the final allotment established for the immediately preceding year. Such national acreage allotment shall be proclaimed not later than December 31 of each year. (7 U.S.C. 1352.)

APPORTIONMENT OF NATIONAL ACREAGE ALLOTMENT

SEC. 353. (a) The national acreage allotment of rice for each calendar year, less a reserve of not to exceed 1 per centum thereof for apportionment by the Secretary as provided in this subsection, shall be apportioned by the Secretary among the several States in which rice is produced in proportion to the average number of acres of rice in each State during the five-year period immediately preceding the calendar year for which such national acreage allotment of rice is determined (plus, in applicable years, the acreage diverted under previous agricultural adjustment and conservation programs) with adjustments for trends in acreage during the applicable period. The Secretary shall provide for the apportionment of the reserve acreage set aside pursuant to this subsection to farms receiving allotments which are inadequate because of an insufficient State or county acreage allotment or because rice was not planted on the farm during all of the preceding five years. Notwithstanding the foregoing provisions of this subsection, the reserve acreage set aside for the 1950 crop pursuant to this subsection shall not exceed one-half of 1 per centum and shall be in addition to the 1950 national acreage allotment as heretofore proclaimed by the Secretary and apportioned by him among the several rice-producing States and shall be available for apportionment to new farms without regard to the limitation contained in subsection (b) of this section. (7 U.S.C. 1353(a).)

(b) The State acreage allotment shall be apportioned to farms owned or operated by persons who have produced rice in the State in any one of the five calendar years immediately preceding the year for which such apportionment is made on the basis of past production of rice in the State by the producer on the farm taking into consideration the acreage allotments previously established in the State for such owners or operators; abnormal conditions affecting acreage; land, labor, and equipment available for the production

of rice; crop rotation practices; and the soil and other physical factors affecting the production of rice: *Provided*, That if the State committee recommends such action and the Secretary determines that such action will facilitate the effective administration of the Act, he may provide for the apportionment of part or all of the State acreage allotment to farms on which rice has been produced during any one of such period of years on the basis of the foregoing factors, using past production of rice on the farm and the acreage allotments previously established for the farm in lieu of past production of rice by the producer and the acreage allotments previously established for such owners or operators:[73] *Provided further*, That if the Secretary determines that part of the State acreage allotment shall be apportioned on the basis of past production of rice by the producer on the farm and part on the basis of the past production of rice on the farm, he shall divide the State into two administrative areas, to be designated "producer administrative area" and "farm administrative area", respectively, which areas shall be separated by a natural barrier which would prevent each area from being readily accessible to rice producers in one area for producing rice in the other area, and each such area shall be composed of whole counties. Not more than 3 per centum of the State acreage allotment shall be apportioned among farms operated by persons who will produce rice in the State during the calendar year for which the allotment is made but who have not produced rice in the State in any one of the past five years, on the basis of the applicable apportionment factors set forth herein: *Provided*, That in any State in which allotments are established for farms on the basis of past production of rice on the farm such percentage of the State acreage allotment shall be apportioned among the farms on which rice is to be planted during the calendar year for which the apportionment is made but on which rice was not planted during any of the past five years, on the basis of the applicable apportionment factors set forth herein. In determining the eligibility of any producer or farm for an allotment as an old producer or farm under the first sentence of this subsection or as a new producer or farm under the second sentence of this subsection, such producer or farm shall not be considered to have produced rice on any acreage which under subsection (c)(2) is either not to be taken into account in establishing acreage allotments or is not to be credited to such producer.[74] For purposes of this section in States which have been divided into administrative areas pursuant to this subsection the term "State acreage allotment" shall be deemed to mean that part of the State acreage allotment apportioned to each administrative area and the word "State" shall be deemed to mean "administrative area", wherever applicable. (7 U.S.C. 1353 (b).)

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[73] Sec. 2(c) of Pub. L. 85–443, 72 Stat. 177, June 4, 1958, provides that the sentence preceding this footnote "shall become effective for the 1958 and subsequent crops of rice: *Provided*, That if any State is divided into administrative areas for 1958 pursuant to section 353(b) of the Act, as amended, acreage allotments heretofore established for farms in such areas shall be redetermined to the extent required as a result of such division: *Provided further*, That the allotment heretofore established for any farm shall not be reduced as a result of such redetermination. The additional acreage, if any, required to provide such minimum allotments shall be in addition to the 1958 National and State acreage allotments."

[74] Sec. 1 of Pub. L. 85–443, 72 Stat. 177, June 4, 1958, provides that the sentence preceding this footnote "shall be applicable to the planting of rice in 1958 and subsequent years."

[Pub. L. 88–160, H.J. Res. 192.[75] * * * That in a State in which farm rice acreage allotments are determined on the basis of past production of rice by the producer on the farm, any producer rice acreage allotment found by the ASC county committee or the ASC State committee to have been properly apportioned from the State rice acreage allotment and the acreage allotment for any farm to which such producer allotment has been allocated and approved by the county committee in good faith for any crop year 1956 to 1962, both inclusive, shall be deemed to have been validly established and shall remain in effect, and the farm marketing quota and farm marketing excess, if any, shall be determined on the basis of such valid farm rice acreage allotment.

This resolution shall not apply to any producer rice allotment or any planted rice acreage that has been obtained by duplication, forgery, bribery, intimidation, or practices that would result in the total allotted acreage in the State exceeding the State acreage allotment, less any unallocated reserve acreage.]

(c) Notwithstanding any other provisions of this Act—

(1) If farm acreage allotments are established by using past production of rice on the farm and the acreage allotments previously established for the farm in lieu of past production of rice by the producer and the acreage allotments previously established for owners or operators, the State acreage allotment shall be apportioned among counties in the State on the same basis as the national acreage allotment is apportioned among the States and the county acreage allotments shall be apportioned to farms on the basis of the applicable factors set forth in subsection (b) of this section: *Provided*, That if the State is divided into administrative areas pursuant to subsection (b) of this section the allotment for each administrative area shall be determined by apportioning the State acreage allotment among counties as provided in this subsection and totaling the allotments for the counties in such area: *Provided*, That the State committee may reserve not to exceed 5 per centum of the State allotment, which shall be used to make adjustments in county allotments for trends in acreage and for abnormal conditions affecting plantings;

(2) Any acreage planted to rice in excess of the farm acreage allotment shall not be taken into account in establishing State, county, and farm acreage allotments.

In determining the past production of rice by producers on a farm for the purpose of establishing farm acreage allotments for the 1956 and subsequent crops, the acreage of rice on the farm for any year for which farm acreage allotments were in effect shall be divided among the producers thereon in the proportion in which they contributed to the farm acreage allotment.

(3) Each of the State acreage allotments for 1955 heretofore proclaimed by the Secretary shall be increased by 2 per centum or by such greater acreage as may be necessary to provide such State with an allotment equal to its 1950 allotment. In any

[75] Pub. L. 88–160, 77 Stat. 279, approved October 28, 1963.

State having county acreage allotments for 1955 (i) the increase in the State allotment shall be apportioned among counties in the State on the same basis as the State allotment was heretofore apportioned among the counties, but without regard to adjustments for trends in acreage, and (ii) the 1955 allotment for any county in which the 1950–1954 average planted plus diverted acreage of rice, adjusted for trends in acreage, exceeds the 1945–1949 average planted acreage of rice, similarly adjusted, by more than 2 per centum shall then be further increased by such additional acreage as may be necessary to provide such county with an allotment equal to its 1950 allotment. The increases in the county acreage allotments and the increases in the State allotments, where county allotments are not determined, shall be used to establish farm acreage allotments which are fair and reasonable in relation to the applicable allotment factors specified in subsection (b) of this section and to correct inequities and prevent hardships.

(4) The reserve acreage made available for 1955 in any State for apportionment to farms operated by persons who have not produced rice during the preceding five years or on which rice has not been planted in the preceding five years shall not be less than five hundred acres; and the additional acreage necessary to provide such minimum reserve acreages shall be in addition to the National and State acreage allotments.

(5) Each of the State acreage allotments for 1956 heretofore proclaimed by the Secretary, after adding thereto any acreage apportioned to farms in the State from the reserve acreage set aside pursuant to subsection (a) of this section, shall be increased by such amount as may be necessary to provide such State with an allotment of not less than 85 per centum of its final allotment established for 1955. Any additional acreage required to provide such minimum allotment shall be additional to the national acreage allotment. In any State having county acreage allotments for 1956, the increase in the State allotment shall be apportioned among counties in the State on the same basis as the State allotment was heretofore apportioned among the counties, but without regard to adjustments for trends in acreage.

(6) [76] The national acreage allotments of rice for 1957 and subsequent years shall be not less than the national acreage allotment for 1956, including any acreage allotted under paragraph (5) of this subsection, and such national allotments for 1957 and subsequent years shall be apportioned among the States in the same proportion that they shared in the total acreage allotted in 1956. (7 U.S.C. 1353(c).)

(d) The provisions of this part shall not apply to nonirrigated rice produced on any farm on which the acreage planted to nonirrigated rice does not exceed three acres or to rice produced outside the continental United States. (7 U.S.C. 1353(d).)

(e) Any part of the farm rice acreage allotment on which rice will not be planted and which is voluntarily surrendered to the county

[76] The words "1957 and subsequent years" substituted for "1957 and 1958" by Pub. L. 85–835, 72 Stat. 994, August 28, 1958.

committee shall be deducted from the allotment to such farm and may be reapportioned by the county committee to other farms in the same county receiving allotments in amounts determined by the county committee to be fair and reasonable on the basis of the past production of rice by the producers on the farm or the past production of rice on the farm, as the case may be; acreage allotments previously established for the farm or for the producers on the farm, as the case may be; abnormal conditions affecting acreage; land, labor, water, and equipment available for the production of rice; crop-rotation practices; and the soil and other physical factors affecting the production of rice. Any allotment surrendered under this provision shall be regarded for the purposes of subsection (b) of this section as having been planted on the farm from which surrendered, except that this shall not operate to make the farm from which the allotment was surrendered eligible for an allotment as having rice planted thereon, or to make any producer thereon eligible for an allotment as having produced rice, during the five-year base period. (7 U.S.C. 1353(e).)

(f)(1) If a producer in a State in which farm rice acreage allotments are determined on the basis of past production of rice by the producer on the farm, dies, his history of rice production shall be apportioned in whole or in part among his heirs or devisees according to the extent to which they may continue, or have continued, his farming operations, if satisfactory proof of such succession of farming operations is furnished the Secretary.

(2) If a producer in a State in which farm rice acreage allotments are determined on the basis of past production of rice by the producer on the farm withdraws in whole or in part from rice production in favor of a member or members of his family who will succeed to his farming operations that portion of his rice history acreage as may be ascribed to such withdrawal may be transferred to such family member or members, as the case may be, if satisfactory proof of such relationship and succession of farming operations by such family member or members is furnished the Secretary.

(3)[77] If a producer in a State in which farm rice acreage allotments are determined on the basis of past production of rice by the producer on the farm permanently withdraws from rice production, his rice history acreage may be transferred to another producer or producers who have had previous rice-producing experience, provided the following conditions are met: (i) The transferee must acquire, except for land, the entire farming operation pertaining to rice, including all production and harvesting equipment, any irrigation equipment not permanently attached to the land; and (ii) the transferee must actually plant at least 90 per centum of his total producer rice acreage allotment, including the allotment determined on the basis of the rice history acreage acquired from the transferor for at least three out of the next four years following the transfer. Failure by the transferee to comply with condition (ii) above shall result in cancellation of the trans-

[77] The words ", except for land," were added and the words ", and any land owned by the transferor to which any of the transferred rice history acreage may be ascribed" were stricken from section 353(3)(i) by Pub. L. 88–261, 78 Stat. 6, approved January 28, 1964.

fer of the rice history acreage. The transferor of rice acreage history under this subsection shall not be eligible for a producer rice acreage allotment for any year subsequent to such transfer, except to the extent that such allotment may be based on rice history acquired in a year (subsequent to the transfer) for which rice acreage allotments are not in effect.

(4) Upon dissolution of a partnership in a State in which farm rice acreage allotments are determined on the basis of past production of rice by the producer on the farm, the partnership's history of rice production shall be divided among the partners in such proportion as agreed upon in writing by the partners: *Provided*, That if a partnership was formed in a year in which allotments were in effect and is dissolved in less than three consecutive crop years after the partnership became effective, the rice acreage allotment established for the partnership and rice history acreages credited to the partnership for each of the years during its existence shall be divided among the partners in the same proportion that each partner contributed to the allotment established for the partnership at the time such partnership was formed. The rice history acreage credited to each of the partners for the years prior to the time the partnership was formed shall revert to the person to whom it was originally credited. (7 U.S.C. 1353(f).)

MARKETING QUOTAS

SEC. 354. (a) Whenever in any calendar year the Secretary determines that the total supply of rice for the marketing year beginning in such calendar year will exceed the normal supply for such marketing year, the Secretary shall not later than December 31 of such calendar year, proclaim such fact and marketing quotas shall be in effect for the crop of rice produced in the next calendar year. (7 U.S.C. 1354(a).)

(b) Within thirty days after the date of the issuance of the proclamation specified in subsection (a) of this section, the Secretary shall conduct a referendum by secret ballot of farmers engaged in the production of the immediately preceding crop of rice to determine whether such farmers are in favor of or opposed to such quotas. If more than one-third of the farmers voting in the referendum oppose such quotas the Secretary shall, prior to the 15th day of February, proclaim the result of the referendum and such quotas shall become ineffective. (7 U.S.C. 1354(b).)

AMOUNT OF FARM MARKETING QUOTA

SEC. 355. The farm marketing quota for any crop of rice shall be the actual production of rice on the farm less the normal production of the acreage planted to rice on the farm in excess of the farm acreage allotment. The normal production from such excess acreage shall be known as the "farm marketing excess": *Provided*, That the farm marketing excess shall not be larger than the amount by which the actual production of rice on the farm exceeds the normal production of the farm acreage allotment if the producer establishes such actual production to the satisfaction of the Secretary. (7 U.S.C. 1355.)

PENALTIES AND STORAGE

SEC. 356. (a) Whenever farm marketing quotas are in effect with respect to any crop of rice, the producer shall be subject to a penalty on the farm marketing excess at a rate per pound equal to 50 per centum of the parity price per pound for rice as of June 15 of the calendar year in which such crop is produced. Effective beginning with the 1958 crop, the rate of penalty on rice shall be 65 per centum of the parity price per pound for rice as of June 15 of the calendar year in which the crop is produced. (7 U.S.C. 1356(a).)

(b) The farm marketing excess of rice shall be regarded as available for marketing and the amount of penalty shall be computed upon the normal production of the acreage on the farm planted to rice in excess of the farm acreage allotment. If a downward adjustment in the amount of the farm marketing excess is made pursuant to the proviso in section 355, the difference between the amount of the penalty computed upon the farm marketing excess before such adjustment and as computed upon the adjusted marketing excess shall be returned to or allowed the producer. (7 U.S.C. 1356(b).)

(c) The person liable for payment or collection of the penalty shall be liable also for interest thereon at the rate of 6 per centum per annum from the date the penalty becomes due until the date of payment of such penalty. (7 U.S.C. 1356(c).)

(d) Until the penalty on the farm marketing excess is paid, postponed, or avoided, as provided herein, all rice produced on the farm and marketed by the producer shall be subject to the penalty provided by this section and a lien on the entire crop of rice produced on the farm shall be in effect in favor of the United States. (7 U.S.C. 1356(d).)

(e) The penalty on the farm marketing excess on any crop of rice may be avoided or postponed by storage or by disposing of the commodity in such other manner, not inconsistent with the purposes of this Act, as the Secretary shall prescribe, including, in the discretion of the Secretary, delivery to Commodity Credit Corporation or any other agency within the Department. The Secretary shall issue regulations governing such storage or other disposition. Unless otherwise specified by the Secretary in such regulations, any quantity of rice so stored or otherwise disposed of shall be of those types and grades which are representative of the entire quantity of rice produced on the farm. Upon failure so to store or otherwise dispose of the farm marketing excess of rice within such time as may be determined under regulations prescribed by the Secretary, the penalty on such excess shall become due and payable. Any rice delivered to any agency of the Department pursuant to this subsection shall become the property of the agency to which delivered and shall be disposed of at the direction of the Secretary in a manner not inconsistent with the purposes of this Act. (7 U.S.C. 1356(e).)

(f) Subject to the provisions of subsection (g) of this section, the penalty upon the farm marketing excess stored pursuant to this section shall be paid by the producer at the time and to the extent of any depletion in the amount so stored except depletion resulting from some

cause beyond the control of the producer or from substitution of the commodity authorized by the Secretary. (7 U.S.C. 1356(f).)

(g) (1) If the planted acreage of the then current crop of rice for any farm is less than the farm acreage allotment, the amount of the commodity from any previous crop of rice stored to postpone or avoid payment of the penalty shall be reduced by an amount equal to the normal production of the number of acres by which the farm acreage allotment exceeds the acreage planted to rice.

(2) If the actual production of the acreage of rice on any farm on which the acreage of rice is within the farm acreage allotment is less than the normal production of the farm acreage allotment, the amount of rice from any previous crop stored to postpone or avoid payment of the penalty shall be reduced by an amount which, together with the actual production of the then current crop will equal the normal production of the farm acreage allotment: *Provided*, That the reduction under this paragraph shall not exceed the amount by which the normal production of the farm acreage allotment less any reduction made under paragraph (1) of this subsection is in excess of the actual production of the acreage planted to rice on the farm. (7 U.S.C. 1356(g).)

(h) Whenever, in any marketing year, marketing quotas are not in effect with respect to the crop of rice produced in the calendar year in which such marketing year begins, all marketing quotas applicable to previous crops of rice shall be terminated, effective as of the first day of such marketing year. Such termination shall not abate any penalty previously incurred by a producer or relieve any buyer of the duty to remit penalties previously collected by him. (7 U.S.C. 1356(h).)

Part VI—Marketing Quotas—Peanuts

Legislative findings

Sec. 357. The production, marketing, and processing of peanuts and peanut products employs a large number of persons and is of national interest. The movement of peanuts from producer to consumer is preponderantly in interstate and foreign commerce, and, owing to causes beyond their control, the farmers producing such commodity and the persons engaged in the marketing and processing thereof are unable to regulate effectively the orderly marketing of the commodity. As the quantity of peanuts marketed in the channels of interstate and foreign commerce increases above the quantity of peanuts needed for cleaning and shelling, the prices at which all peanuts are marketed are depressed to low levels. These low prices tend to cause the quantity of peanuts available for marketing in later years to be less than normal, which in turn tends to cause relatively high prices. This fluctuation of prices and marketings of peanuts creates an unstable and chaotic condition in the marketing of peanuts for cleaning and shelling and for crushing for oil in the channels of interstate and foreign commerce. Since these unstable and chaotic conditions have existed for a period of years and are likely, without

proper regulation, to continue to exist, it is imperative that the marketing of peanuts for cleaning and shelling and for crushing for oil in interstate and foreign commerce be regulated in order to protect producers, handlers, processors, and consumers. (7 U.S.C. 1357.)

MARKETING QUOTAS

SEC. 358. (a) Between July 1 and December 1 of each calendar year the Secretary shall proclaim the amount of the national marketing quota for peanuts for the crop produced in the next succeeding calendar year in terms of the total quantity of peanuts which will make available for marketing a supply of peanuts from the crop with respect to which the quota is proclaimed equal to the average quantity of peanuts harvested for nuts during the five years immediately preceding the year in which such quota is proclaimed, adjusted for current trends and prospective demand conditions, and the quota so proclaimed shall be in effect with respect to such crop. The national marketing quota for peanuts for any year shall be converted to a national acreage allotment by dividing such quota by the normal yield per acre of peanuts for the United States determined by the Secretary on the basis of the average yield per acre of peanuts in the five years preceding the year in which the quota is proclaimed, with such adjustments as may be found necessary to correct for trends in yields and for abnormal conditions of production affecting yields in such five years: *Provided*, That the national marketing quota established for the crop produced in the calendar year 1941 shall be a quantity of peanuts sufficient to provide a national acreage allotment of not less than one million six hundred and ten thousand acres, and that the national marketing quota established for any subsequent year shall be a quantity of peanuts sufficient to provide a national acreage allotment of not less than that established for the crop produced in the calendar year 1941. (7 U.S.C. 1358(a).)

(b) Not later than December 15 of each calendar year the Secretary shall conduct a referendum of farmers engaged in the production of peanuts in the calendar year in which the referendum is held to determine whether such farmers are in favor of or opposed to marketing quotas with respect to the crops of peanuts produced in the three calendar years immediately following the year in which the referendum is held, except that, if as many as two-thirds of the farmers voting in any referendum vote in favor of marketing quotas, no referendum shall be held with respect to quotas for the second and third years of the period. The Secretary shall proclaim the results of the referendum within thirty days after the date on which it is held, and, if more than one-third of the farmers voting in the referendum vote against marketing quotas, the Secretary also shall proclaim that marketing quotas will not be in effect with respect to the crop of peanuts produced in the calendar year immediately following the calendar year in which the referendum is held. (7 U.S.C. 1358(b).)

(c)(1) The national acreage allotment for 1951, less the acreage to be allotted to new farms under subsection (f) of this section, shall be apportioned among the States on the basis of the larger of the following for each State: (a) The acreage allotted

to the State as its share of the 1950 national acreage allotment of two million one hundred thousand acres, or (b) the State's share of two million one hundred thousand acres apportioned to States on the basis of the average acreage harvested for nuts in each State in the five years 1945–49: *Provided*, That any allotment so determined for any State which is less than the 1951 State allotment announced by the Secretary prior to the enactment of this Act shall be increased to such announced allotment and the acreage required for such increases shall be in addition to the 1951 national acreage allotment and shall be considered in determining State acreage allotments in future years. For any year subsequent to 1951, the national acreage allotment for that year, less the acreage to be allotted to new farms under subsection (f) of this section, shall be apportioned among the States on the basis of their share of the national acreage allotment for the most recent year in which such apportionment was made.

(2) Notwithstanding any other provision of law, if the Secretary of Agriculture determines, on the basis of the average yield per acre of peanuts by types during the preceding five years, adjusted for trends in yields and abnormal conditions of production affecting yields in such five years, that the supply of any type or types of peanuts for any marketing year, beginning with the 1951–52 marketing year, will be insufficient to meet the estimated demand for cleaning and shelling purposes at prices at which the Commodity Credit Corporation may sell for such purposes peanuts owned or controlled by it, the State allotments for those States producing such type or types of peanuts shall be increased to the extent determined by the Secretary to be required to meet such demand but the allotment for any State may not be increased under this provision above the 1947 harvested acreage of peanuts for such State. The total increase so determined shall be apportioned among such States for distribution among farms producing peanuts of such type or types on the basis of the average acreage of peanuts of such type or types in the three years immediately preceding the year for which the allotments are being determined. The additional acreage so required shall be in addition to the national acreage allotment, the production from such acreage shall be in addition to the national marketing quota, and the increase in acreage allotted under this provision shall not be considered in establishing future State, county, or farm acreage allotments. (7 U.S.C. 1358(c).)

(d) The Secretary shall provide for apportionment of the State acreage allotment for any State through local committees among farms on which peanuts were grown in any of the three years immediately preceding the year for which such allotment is determined. The State acreage allotment for 1952 and any subsequent year shall be apportioned among farms on which peanuts were produced in any one of the 3 calendar years immediately preceding the year for which such apportionment is made, on the basis of the following: Past acreage of peanuts, taking into consideration the acreage allotments previously established for the farm; abnormal conditions affecting

acreage; land, labor, and equipment available for the production of peanuts; crop-rotation practices; and soil and other physical factors affecting the production of peanuts. Any acreage of peanuts harvested in excess of the allocated acreage for any farm for any year shall not be considered in the establishment of the allotment for the farm in succeeding years. The amount of the marketing quota for each farm shall be the actual production of the farm-acreage allotment, and no peanuts shall be marketed under the quota for any farm other than peanuts actually produced on the farm. (7 U.S.C. 1358(d).)

(e) Notwithstanding the foregoing provisions of this section, the Secretary may, if the State committee recommends such action and the Secretary determines that such action will facilitate the effective administration of the provisions of the Act, provide for the apportionment of the State acreage allotment for 1952 and any subsequent year among the counties in the State on the basis of the past acreage of peanuts harvested for nuts (excluding acreage in excess of farm allotments) in the county during the five years immediately preceding the year in which such apportionment is made, with such adjustments as are deemed necessary for abnormal conditions affecting acreage, for trends in acreage, and for additional allotments for types of peanuts in short supply under the provisions of subsection (c). The county acreage allotment shall be apportioned among farms in the basis of the factors set forth in subsection (d) of this section. (7 U.S.C. 1358(e).)

(f) Not more than one per centum of the national acreage allotment shall be apportioned among farms on which peanuts are to be produced during the calendar year for which the allotment is made but on which peanuts were not produced during any one of the past three years, on the basis of the following: Past peanut-producing experience by the producers; land, labor, and equipment available for the production of peanuts; crop-rotation practices; and soil and other physical factors affecting the production of peanuts. (7 U.S.C. 1358(f).)

(g) Any part of the acreage allotted to individual farms under the provisions of this section on which peanuts will not be produced and which is voluntarily surrendered to the county committee shall be deducted from the allotments to such farms and may be reapportioned by the county committee to other farms in the same county receiving allotments, in amounts determined by the county committee to be fair and reasonable on the basis of land, labor, and equipment available for the production of peanuts, crop-rotation practices, and soil and other physical factors affecting the production of peanuts. Any transfer of allotments under this provision shall not operate to reduce the allotment for any subsequent year for the farm from which acreage is transferred, except as the farm becomes ineligible for an allotment by failure to produce peanuts during a three-year period, and any such transfer shall not operate to increase the allotment for any subsequent year for the farm to which the acreage is transferred: *Provided*, That, notwithstanding any other provisions of this Act, any part of any farm acreage allotment may be permanently released

in writing to the county committee by the owner and operator of the farm, and reapportioned as provided herein. (7 U.S.C. 1358(g).)

(h)[78] * * *

(i) The production of peanuts on a farm in 1959 or any subsequent year for which no farm acreage allotment was established shall not make the farm eligible for an allotment as an old farm under subsection (d) of this section: *Provided, however*, That by reason of such production the farm need not be considered as ineligible for a new farm allotment under subsection (f) of this section, but such production shall not be deemed past experience in the production of peanuts for any producer on the farm. (7 U.S.C. 1358(i).)

MARKETING PENALTIES

SEC. 359. (a) The marketing of any peanuts in excess of the marketing quota for the farm on which such peanuts are produced, or the marketing of peanuts from any farm for which no acreage allotment was determined, shall be subject to a penalty at a rate equal to 75 per centum of the support price for peanuts for the marketing year (August 1–July 31). Such penalty shall be paid by the person who buys or otherwise acquires the peanuts from the producer, or if the peanuts are marketed by the producer through an agent, the penalty shall be paid by such agent, and such person or agent may deduct an amount equivalent to the penalty from the price paid to the producer. The Secretary may require collection of the penalty upon a portion of each lot of peanuts marketed from the farm equal to the proportion which the acreage of peanuts in excess of the farm-acreage allotment is of the total acreage of peanuts on the farm. If the person required to collect the penalty fails to collect such penalty, such person and all persons entitled to share in the peanuts marketed from the farm or the proceeds thereof shall be jointly and severally liable for the amount of the penalty. All funds collected pursuant to this section shall be deposited in a special deposit account with the Treasurer of the United States and such amounts as are determined, in accordance with regulations prescribed by the Secretary, to be penalties incurred shall be transferred to the general fund of the Treasury of the United States. Amounts collected in excess of determined penalties shall be paid to such producers as the Secretary determines, in accordance with regulations prescribed by him, bore the burden of the payment of the amount collected. Such special account shall be administered by the Secretary and the basis for, the amount of, and the producer entitled to receive a payment from such account, when determined in accordance with regulations prescribed by the Secretary, shall be final and conclusive. Peanuts produced in a calendar year in which marketing quotas are in effect for the marketing year beginning therein shall be subject to such quotas even though the peanuts are marketed prior to the date on which such marketing year begins. If any producer falsely identifies or fails to account for the disposition of any peanuts, an amount of peanuts equal to the normal yield of the number of acres harvested in excess of the farm acreage

[78] Repealed by Pub. L. 85–835, 72 Stat. 996, approved August 28, 1958.

allotment shall be deemed to have been marketed in excess of the marketing quota on the farm, and the penalty in respect thereof shall be paid and remitted by the producer. If any amount of peanuts produced on one farm is falsely identified by a representation that such peanuts were produced on another farm, the acreage allotments next established for both such farms shall be reduced by that percentage which such amount was of the respective farm marketing quotas, except that such reduction for any such farm shall not be made if the Secretary through the local committee finds that no person connected with such farm caused, aided, or acquiesced in such marketing; and if proof of the disposition of any amount of peanuts is not furnished as required by the Secretary, the acreage allotment next established for the farm on which such peanuts are produced shall be reduced by a percentage similarly computed. Notwithstanding any other provisions of this title, no refund of any penalty shall be made because of peanuts kept on the farm for seed or for home consumption. (7 U.S.C. 1359(a).)

(b) The provisions of this part shall not apply, beginning with the 1959 crop, to peanuts produced on any farm on which the acreage harvested for nuts is one acre or less provided the producers who share in the peanuts produced on such farm do not share in the peanuts produced on any other farm. If the producers who share in the peanuts produced on a farm on which the acreage harvested for nuts is one acre or less also share in the peanuts produced on other farm(s) the peanuts produced on such farm on acreage in excess of the allotment, if any, determined for the farm shall be considered as excess acreage and the marketing penalties provided by section 359 (a) shall apply. (7 U.S.C. 1359(b).)

(c) [79] The word "peanuts" for the purposes of this Act shall mean all peanuts produced, excluding any peanuts which it is established by the producer or otherwise, in accordance with regulations of the Secretary, were not picked or threshed either before or after marketing from the farm, or were marketed by the producer before drying or removal of moisture from such peanuts either by natural or artificial means for consumption exclusively as boiled peanuts. (7 U.S.C. 1359(c).)

(d) The person liable for payment or collection of the penalty provided by this section shall be liable also for interest thereon at the rate of 6 per centum per annum from the date the penalty becomes due until the date of payment of such penalty. (7 U.S.C. 1359(d).)

(e) Until the amount of the penalty provided by this section is paid, a lien on the crop of peanuts with respect to which such penalty is incurred, and on any subsequent crop of peanuts subject to marketing quotas in which the person liable for payment of the penalty has an interest shall be in effect in favor of the United States. (7 U.S.C. 1359(e).)

(f)–(i) [80] * * *

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[79] "Boiled peanuts" were exempted from the definition of "peanuts" for 1964 and 1965 by Pub. L. 88–76, 77 Stat. 92, approved July 25, 1963.

[80] Repealed by Act of March 28, 1956, 66 Stat. 27.

SUBTITLE C—ADMINISTRATIVE PROVISIONS

PART I—PUBLICATION AND REVIEW OF QUOTAS

APPLICATION OF PART

SEC. 361. This part shall apply to the publication and review of farm marketing quotas established for tobacco, corn, wheat, cotton, peanuts, and rice, established under subtitle B. (7 U.S.C. 1361.)

PUBLICATION AND NOTICE OF QUOTA

SEC. 362. All acreage allotments, and the farm marketing quotas established for farms in a county or other local administrative area shall, in accordance with regulations of the Secretary, be made and kept freely available for public inspection in such county or other local administrative area. An additional copy of this information shall be kept available in the office of the county agricultural extension agent or with the chairman of the local committee. Notice of the farm marketing quota of his farm shall be mailed to the farmer.

Notice of the farm acreage allotment established for each farm shown by the records of the county committee to be entitled to such allotment shall insofar as practicable be mailed to the farm operator in sufficient time to be received prior to the date of the referendum. (7 U.S.C. 1362.)

REVIEW BY REVIEW COMMITTEE

SEC. 363. Any farmer who is dissatisfied with his farm marketing quota may, within fifteen days after mailing to him of notice as provided in section 362, have such quota reviewed by a local review committee composed of three farmers from the same or nearby counties appointed by the Secretary. Such committee shall not include any member of the local committee which determined the farm acreage allotment, the normal yield, or the farm marketing quota for such farm. Unless application for review is made within such period, the original determination of the farm marketing quota shall be final. (7 U.S.C. 1363.)

REVIEW COMMITTEE

SEC. 364. The members of the review committee shall receive as compensation for their services the same per diem as that received by the members of the committee utilized for the purposes of the Soil Conservation and Domestic Allotment Act, as amended. The members of the review committee shall not be entitled to receive compensation for more than thirty days in any one year. (7 U.S.C. 1364.)

INSTITUTION OF PROCEEDINGS

SEC. 365. If the farmer is dissatisfied with the determination of the review committee, he may, within fifteen days after a notice of such determination is mailed to him by registered mail or by certified mail,

file a bill in equity against the review committee as defendant in the United States district court, or institute proceedings for review in any court of record of the State having general jurisdiction, sitting in the county or the district in which his farm is located, for the purpose of obtaining a review of such determination. Bond shall be given in an amount and with surety satisfactory to the court to secure the United States for the costs of the proceeding. The bill of complaint in such proceeding may be served by delivering a copy thereof to any one of the members of the review committee. Thereupon the review committee shall certify and file in the court a transcript of the record upon which the determination complained of was made, together with its findings of fact. (7 U.S.C. 1365.)

COURT REVIEW

SEC. 366. The review by the court shall be limited to questions of law, and the findings of fact by the review committee, if supported by evidence, shall be conclusive. If application is made to the court for leave to adduce additional evidence, and it is shown to the satisfaction of the court that such additional evidence is material and that there were reasonable grounds for failure to adduce such evidence in the hearing before the review committee, the court may direct such additional evidence to be taken before the review committee in such manner and upon such terms and conditions as to the court may seem proper. The review committee may modify its findings of fact or its determination by reason of the additional evidence so taken, and it shall file with the court such modified findings or determination, which findings of fact shall be conclusive. At the earliest convenient time, the court, in term time or vacation, shall hear and determine the case upon the original record of the hearings before the review committee and upon such record as supplemented, if supplemented, by further hearing before the review committee pursuant to direction of the court. The court shall affirm the review committee's determination, or modified determination, if the court determines that the same is in accordance with law. If the court determines that such determination or modified determination is not in accordance with law, the court shall remand the proceedings to the review committee with direction either to make such determination as the court shall determine to be in accordance with law or to take such further proceedings as, in the court's opinion, the law requires. (7 U.S.C. 1366.)

STAY ON PROCEEDINGS AND EXCLUSIVE JURISDICTION

SEC. 367. The commencement of judicial proceedings under this part shall not, unless specifically ordered by the court, operate as a stay of the review committee's determination. Notwithstanding any other provision of law, the jurisdiction conferred by this part to review the legal validity of a determination made by a review committee pursuant to this part shall be exclusive. No court of the United States or of any State shall have jurisdiction to pass upon the legal validity of any such determination except in a proceeding under this part. (7 U.S.C. 1367.)

NO EFFECT ON OTHER QUOTAS

SEC. 368. Notwithstanding any increase of any farm marketing quota for any farm as a result of review of the determination thereof under this part, the marketing quotas for other farms shall not be affected. (7 U.S.C. 1368.)

PART II—ADJUSTMENT OF QUOTAS AND ENFORCEMENT

GENERAL ADJUSTMENTS OF QUOTAS

SEC. 371.[81] (a) If at any time the Secretary has reason to believe that in the case of cotton, rice, peanuts, or tobacco the operation of farm marketing quotas in effect will cause the amount of such commodity which is free of marketing restrictions to be less than the normal supply for the marketing year for the commodity then current, he shall cause an immediate investigation to be made with respect thereto. In the course of such investigation due notice and opportunity for hearing shall be given to interested persons. If upon the basis of such investigation the Secretary finds the existence of such fact, he shall proclaim the same forthwith. He shall also in such proclamation specify such increase in, or termination of, existing quotas as he finds, on the basis of such investigation, is necessary to make the amount of such commodity which is free of marketing restrictions equal to the normal supply. (7 U.S.C. 1371(a).)

(b)[82] If the Secretary has reason to believe that, because of a national emergency or because of a material increase in export demand, any national marketing quota or acreage allotment for cotton, rice, peanuts, or tobacco should be increased or terminated, he shall cause an immediate investigation to be made to determine whether the increase or termination is necessary to meet such emergency or increase in export demand. If, on the basis of such investigation, the Secretary finds that such increase or termination is necessary, he shall immediately proclaim such finding (and if he finds an increase is necessary, the amount of the increase found by him to be necessary) and thereupon such quota or allotment shall be increased, or shall terminate, as the case may be. (7 U.S.C. 1371(b).)

(c) In case any national marketing quota or acreage allotment for any commodity is increased under this section, each farm marketing quota or acreage allotment for the commodity shall be increased in the same ratio. (7 U.S.C. 1371(c).)

(d)[83] * * *

PAYMENT AND COLLECTION OF PENALTIES

SEC. 372. (a) The penalty with respect to the marketing, by sale, of wheat, cotton, or rice, if the sale is to any person within the United States, shall be collected by the buyer. (7 U.S.C. 1372(a).)

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[81] The words, "corn, wheat," were deleted from the first sentence of subsection (a) by Pub. L. 87–703, 76 Stat. 626, approved September 27, 1962.

[82] The words, "any national acreage allotment for corn or", "wheat," and "in order to effect the declared policy of this act or" in subsection (b) were deleted by Pub. L. 87–703, 76 Stat. 626, approved September 27, 1962.

[83] Repealed by Pub. L. 690, 83d Cong., 68 Stat. 905, approved August 28, 1954.

(b) All penalties provided for in Subtitle B shall be collected and paid in such manner, at such times, and under such conditions as the Secretary may by regulations prescribe. Such penalties shall be remitted to the Secretary by the person liable for the penalty, except that if any other person is liable for the collection of the penalty, such other person shall remit the penalty. The amount of such penalties shall be covered into the general fund of the Treasury of the United States. (7 U.S.C. 1372(b).)

(c) Whenever, pursuant to a claim filed with the Secretary within two years after payment to him of any penalty collected from any person pursuant to this Act, the Secretary finds that such penalty was erroneously, illegally, or wrongfully collected and that the claimant bore the burden of the payment of such penalty, the Secretary shall certify to the Secretary of the Treasury for payment to the claimant, in accordance with regulations prescribed by the Secretary of the Treasury, such amounts as the Secretary finds the claimant is entitled to receive as a refund of such penalty.

Notwithstanding any other provision of the law, the Secretary is authorized to prescribe by regulations for the identification of farms and it shall be sufficient to schedule receipts into special deposit accounts or to schedule such receipts for transfer therefrom, or directly, into the separate fund provided for in subsection (b) hereof by means of such identification without reference to the names of the producers on such farms.

The Secretary is authorized to prescribe regulations governing the filing of such claims and the determination of such refunds. (7 U.S.C. 1372(c).)

(d) No penalty shall be collected under this Act with respect to the marketing of any agricultural commodity grown for experimental purposes only by any publicly owned agricultural experiment station. (7 U.S.C. 1372(d).)

REPORTS AND RECORDS

SEC. 373. (a) This subsection shall apply to warehousemen, processors, and common carriers of corn, wheat, cotton, rice, peanuts, or tobacco, and all ginners of cotton, all persons engaged in the business of purchasing corn, wheat, cotton, rice, peanuts, or tobacco from producers, all persons engaged in the business of redrying, prizing, or stemming tobacco for producers, all brokers and dealers in peanuts, all agents marketing peanuts for producers, or acquiring peanuts for buyers and dealers, and all peanut growers' cooperative associations, all persons engaged in the business of cleaning, shelling, crushing, and salting of peanuts and the manufacture of peanut products, and all persons owning or operating peanut-picking or peanut-threshing machines. Any such person shall, from time to time on request of the Secretary, report to the Secretary such information and keep such records as the Secretary finds to be necessary to enable him to carry out the provisions of this title. Such information shall be reported and such records shall be kept in accordance with forms which the Secretary shall prescribe. For the purpose of ascertaining the correctness of any report made or record kept, or of obtaining informa-

tion required to be furnished in any report, but not so furnished, the Secretary is hereby authorized to examine such books, papers, records, accounts, correspondence, contracts, documents, and memoranda as he has reason to believe are relevant and are within the control of such person. Any such person failing to make any report or keep any record as required by this subsection or making any false report or record shall be deemed guilty of a misdemeanor and upon conviction thereof shall be subject to a fine of not more than $500; and any tobacco warehouseman or dealer who fails to remedy such violation by making a complete and accurate report or keeping a complete and accurate record as required by this subsection within fifteen days after notice to him of such violation shall be subject to an additional fine of $100 for each ten thousand pounds of tobacco, or fraction thereof, bought or sold by him after the date of such violation: *Provided*, That such fine shall not exceed $5,000; and notice of such violation shall be served upon the tobacco warehouseman or dealer by mailing the same to him by registered mail or by certified mail or by posting the same at any established place of business operated by him, or both. (7 U.S.C. 1373(a).)

(b) Farmers engaged in the production of corn, wheat, cotton, rice, peanuts, or tobacco for market shall furnish such proof of their acreage, yield, storage, and marketing of the commodity in the form of records, marketing cards, reports, storage under seal, or otherwise as the Secretary may prescribe as necessary for the administration of this title. (7 U.S.C. 1373(b).)

(c) All data reported to or acquired by the Secretary pursuant to this section shall be kept confidential by all officers and employees of the Department, and only such data so reported or acquired as the Secretary deems relevant shall be disclosed by them, and then only in a suit or administrative hearing under this title. (7 U.S.C. 1373(c).)

MEASUREMENT OF FARMS AND REPORT OF PLANTINGS

SEC. 374. (a) The Secretary shall provide, through the county and local committees, for measuring farms on which corn, wheat, cotton, peanuts, or rice is produced and for ascertaining whether the acreage planted for any year to any such commodity is in excess of the farm acreage allotment for such commodity for the farm under this title. If in the case of any farm the acreage planted to any such commodity on the farm is in excess of the farm acreage allotment for such commodity for the farm, the committee shall file with the State committee a written report stating the total acreage on the farm in cultivation and the acreage planted to such commodity. (7 U.S.C. 1374(a).)

(b) With respect to cotton, the Secretary, upon such terms and conditions as he may by regulation prescribe, shall provide, through the county and local committees for the measurement prior to planting of an acreage on the farm equal to the farm acreage allotment if so requested by the farm operator, and any farm on which the acreage

planted to cotton does not exceed such measured acreage shall be deemed to be in compliance with the farm acreage allotment. (7 U.S.C. 1374(b).)

(c) If the acreage determined to be planted to any basic agricultural commodity on the farm is in excess of the farm acreage allotment, the Secretary shall by appropriate regulations provide for a reasonable time prior to harvest within which such planted acreage may be adjusted to the farm acreage allotment. The Secretary shall by appropriate regulations provide for the remeasurement upon request by the farm operator of the acreage planted to such commodity on the farm and for the measurement of the acreage planted to such commodity on the farm remaining after any adjustment of excess acreage hereunder and shall prescribe the conditions under which the farm operator shall be required to pay the county committee for the expense of the measurement of adjusted acreage or the expense of remeasurement after the initial measurement or the measurement of adjusted acreage. The regulations shall also provide for the refund of any deposit or payment made for the expense of the remeasurement of the initially determined acreage or the adjusted acreage when because of an error in the determination of such acreage the remeasurement brings the acreage within the allotment or permitted acreage or results in a change in acreage in excess of a reasonable variation normal to measurements of acreage of the commodity. Unless the requirements for measurement of adjusted acreage are met by the farm operator, the acreage prior to such adjustment as determined by the county committee shall be considered the acreage of the commodity on the farm in determining whether the applicable farm allotment has been exceeded. (7 U.S.C. 1374(c).)

REGULATIONS

SEC. 375. (a) The Secretary shall provide by regulations for the identification, wherever necessary, of corn, wheat, cotton, rice, peanuts, or tobacco so as to afford aid in discovering and identifying such amounts of the commodities as are subject to and such amounts thereof as are not subject to marketing restrictions in effect under this title. (7 U.S.C. 1375(a).)

(b) The Secretary shall prescribe such regulations as are necessary for the enforcement of this title. (7 U.S.C. 1375(b).)

COURT JURISDICTION

SEC. 376.[84] The several district courts of the United States are hereby vested with jurisdiction specifically to enforce the provisions of this title. If and when the Secretary shall so request, it shall be the duty of the several United States attorneys in their respective districts, under the direction of the Attorney General, to institute proceedings to collect the penalties provided in this title. The remedies and penalties provided for herein shall be in addition to, and not exclusive of,

[84] Last sentence in this section 376 was added by Pub. L. 88–297, 78 Stat. 176, approved April 11, 1964.

any of the remedies or penalties under existing law. This section also shall be applicable to liquidated damages provided for pursuant to section 349 of this title. (7 U.S.C. 1376.)

PRESERVATION OF UNUSED ACREAGE ALLOTMENTS

SEC. 377. In any case in which, during any year beginning with 1956, the acreage planted to a commodity on any farm is less than the acreage allotment for such farm, the entire acreage allotment for such farm (excluding any allotment released from the farm or reapportioned to the farm and any allotment provided for the farm pursuant to subsection (f)(7)(A) of section 344) shall, except as provided herein, be considered for the purpose of establishing future State, county and farm acreage allotments to have been planted to such commodity in such year on such farm, but the 1956 acreage allotment of any commodity shall be regarded as planted under this section only if the owner or operator on such farm notified the county committee prior to the sixtieth day preceding the beginning of the marketing year for such commodity of his desire to preserve such allotment: *Provided*, That beginning with the 1960 crop, except for federally owned land, the current farm acreage allotments established for a commodity shall not be preserved as history acreage pursuant to the provisions of this section unless for the current year or either of the two preceding years an acreage equal to 75 per centum or more of the farm acreage allotment for such year or, in the case of upland cotton on a farm which qualified for price support on the crop produced in any such year under section 103(b) of the Agricultural Act of 1949, as amended, 75 per centum of the farm domestic allotment established under section 350 for any such year, whichever is smaller[85] was actually planted or devoted to the commodity on the farm (or was regarded as planted under provisions of the Soil Bank Act or the Great Plains program): *Provided further*, That this section shall not be applicable in any case, within the period 1956 to 1959, in which the amount of the commodity required to be stored to postpone or avoid payment of penalty has been reduced because the allotment was not fully planted. Acreage history credits for released or reapportioned acreage shall be governed by the applicable provisions of this title pertaining to the release and reapportionment of acreage allotments. (7 U.S.C. 1377.)

EMINENT DOMAIN

SEC. 378.[86] (a) Notwithstanding any other provision of this Act, the allotment determined for any commodity for any land from which

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[85] Pub. L. 88-297, 78 Stat. 177, approved April 11, 1964, amended the first proviso of section 377 by adding the following language: "or, in the case of upland cotton on a farm which qualified for price support on the crop produced in any such year under section 103(b) of the Agricultural Act of 1949, as amended, 75 per centum of the farm domestic allotment established under section 350 for any such year, whichever is smaller".

[86] Sees. 313(h), 334(d), 344(h), 353(f) and 358(h) of the Agricultural Adjustment Act of 1938, as amended, were repealed by Pub. L. 85-835, 72 Stat. 995, approved August 28, 1958. Any transfer or reassignment of allotment heretofore made under the provisions of these sections shall remain in effect, and any displaced farm owner for whom an allotment has been established under such repealed sections shall not be eligible for additional allotment under section 378(a) because of such displacement.

the owner is displaced because of acquisition of the land for any purpose, other than for the continued production of allotted crops, by any Federal, State, or other agency having the right of eminent domain shall be placed in an allotment pool and shall be available only for use in providing allotments for other farms owned by the owners so displaced. Upon application to the county committee, within three years after the date of such displacement, or three years after the enactment of this section, whichever period is longer, any owner so displaced shall be entitled to have established for other farms owned by him allotments which are comparable with allotments determined for other farms in the same area which are similar except for the past acreage of the commodity, taking into consideration the land, labor, and equipment available for the production of the commodity, crop-rotation practices, and the soil and other physical factors affecting the production of the commodity: *Provided*, That the acreage used to establish or increase the allotments for such farms shall be transferred from the pool and shall not exceed the allotment most recently established for the farm acquired from the applicant and placed in the pool. During the period of eligibility for the making of allotments under this section for a displaced owner, acreage allotments for the farm from which the owner was so displaced shall be established in accordance with the procedure applicable to other farms, and such allotments shall be considered to have been fully planted. After such allotment is made under this section, the proportionate part, or all, as the case may be, of the past acreage used in establishing the allotment most recently placed in the pool for the farm from which the owner was so displaced shall be transferred to and considered for the purposes of future State, county, and farm acreage allotments to have been planted on the farm to which allotment is made under this section. Except where paragraph (c) requires the transfer of allotment to another portion of the same farm, for the purpose of this section (1) that part of any farm from which the owner is so displaced and that part from which he is not so displaced shall be considered as separate farms; and (2) an owner who voluntarily relinquishes possession of the land subsequent to its acquisition by an agency having the right of eminent domain shall be considered as having been displaced because of such acquisition. The former owner of land acquired as described in this subsection shall not be considered for the purposes hereof to have been displaced from such land during any period for which such land is leased to such former owner: *Provided*, That the occupancy of the former owner under the lease follows immediately after his occupancy as owner: *And provided further*, That if a former owner has been displaced prior to the effective date of this amendment and no allotment from the land owned by such former owner has been transferred from the allotment pool and such former owner leases the land formerly owned by him prior to two years from the effective date of this amendment such allotment shall be retransferred from the pool to such land and the occupancy of such former owner under the lease for the purposes of this subsection shall be deemed to have begun immediately after his displacement as owner. During any year of the 3-year period the allotment from a

farm may remain in the allotment pool, the displaced owner may, in accordance with regulations of the Secretary, release for one year at a time any part or all of such farm allotment to the county committee for reapportionment to other farms in the county having allotments for such commodity on the basis of the past acreage of the commodity, land, labor, equipment available for the production of the commodity, crop rotation practices, and soil and other physical facilities affecting the production of the commodity; and the allotment reapportioned shall, for purposes of establishing future farm allotments, not be regarded as planted on the farm to which the allotment was transferred. (7 U.S.C. 1378(a).)

(b) The provisions of this section shall not be applicable if (1) there is any marketing quota penalty due with respect to the marketing of the commodity from the farm acquired by the Federal, State, or other agency or by the owner of the farm; (2) any of the commodity produced on such farm has not been accounted for as required by the Secretary; or (3) the allotment next established for the farm acquired by the Federal, State, or other agency would have been reduced because of false or improper identification of the commodity produced on or marketed from such farm or due to a false acreage report. (7 U.S.C. 1378(b).)

(c) This section shall not be applicable, in the case of cotton, tobacco, and peanuts, to any farm from which the owner was displaced prior to 1950, in the case of wheat and corn, to any farm from which the owner was displaced prior to 1954, and in the case of rice, to any farm from which the owner was displaced prior to 1955. In any case where the cropland acquired for nonfarming purposes from an owner by an agency having the right of eminent domain represents less than 15 per centum of the total cropland on the farm, the allotment attributable to that portion of the farm so acquired shall be transferred to that portion of the farm not so acquired. (7 U.S.C. 1378(c).)

Subtitle D—Wheat Marketing Allocation

LEGISLATIVE FINDINGS

Sec. 379a. Wheat, in addition to being a basic food, is one of the great export crops of American agriculture and its production for domestic consumption and for export is necessary to the maintenance of a sound national economy and to the general welfare. The movement of wheat from producer to consumer, in the form of the commodity or any of the products thereof, is preponderantly in interstate and foreign commerce. Unreasonably low prices of wheat to producers impair their purchasing power for nonagricultural products and place them in a position of serious disparity with other industrial groups. The conditions affecting the production of wheat are such that without Federal assistance, producers cannot effectively prevent disastrously low prices for wheat. It is necessary, in order to assist wheat producers in obtaining fair prices, to regulate the price of wheat used for domestic food and for exports in the manner provided in this subtitle. (7 U.S.C. 1379a.)

WHEAT MARKETING ALLOCATION

[Sec. 379b as set out below is effective with respect to the crops planted for harvest in 1964 and 1965.]

Sec. 379b.[87] *A wheat marketing allocation program as provided in this subtitle shall be in effect for the marketing years for the 1964 and 1965 crops. Whenever a wheat marketing allocation program is in effect for any marketing year the Secretary shall determine (1) the wheat marketing allocation for such year which shall be the amount of wheat he estimates will be used during such year for food products for consumption in the United States and that portion of the amount of wheat which he estimates will be exported in the form of wheat or products thereof during the marketing year on* (sic) *which the Secretary determines that marketing certificates shall be issued to producers in order to achieve, insofar as practicable, the price and income objectives of this subtitle, and (2) the national allocation percentage for such year which shall be the percentage which the national marketing allocation is of the national marketing quota proclaimed for the 1964 crop, less the expected production on the acreage allotments for farms which will not be in compliance with the requirements of the program. Each farm shall receive a wheat marketing allocation for such marketing year equal to the number of bushels obtained by multiplying the number of acres in the farm acreage allotment for wheat by the normal yield of wheat for the farm as determined by the Secretary, and multiplying the resulting number of bushels by the national allocation percentage. (7 U.S.C. 1379b.)*

[Sec. 379b as set out below is effective with respect to the crops planted for harvest in the calendar year 1966 and any subsequent year.]

SEC. 379b. During any marketing year for which a marketing quota is in effect for wheat, beginning with the marketing year for the 1964 crop, a wheat marketing allocation program shall be in effect as provided in this subtitle. Whenever a wheat marketing allocation program is in effect for any marketing year the Secretary shall determine (1) the wheat marketing allocation for such year which shall be the amount of wheat which in determining the national marketing quota for such marketing year he estimated would be used during such year for food products for consumption in the United States,[88] and that portion of the amount of wheat which in determining such quota he estimated would be exported in the form of wheat or products thereof during the marketing year on (sic) which the Secretary determines that marketing certificates shall be issued to producers in order to achieve, insofar as practicable, the price and income objectives of this subtitle, and (2) the national allocation percentage which shall be the percentage which the national marketing allocation is of the national marketing quota. Each farm shall receive a wheat marketing allocation for such marketing year equal to the number of bushels obtained by mul-

[87] Section 379b amended by Pub. L. 88–297, 78 Stat. 179, approved April 11, 1964, but is in effect only with respect to the crops planted for harvest in 1964 and 1965.

[88] Pub. L. 88–297, 78 Stat. 180, approved April 11, 1964, amended the second sentence of section 379b by deleting the words, "human consumption in the United States, as food, food products, and beverages, composed wholly or partly of wheat" and substituted in lieu thereof the language, "food products for consumption in the United States", and made the entire subsection, as amended, effective with respect to crops planted for harevst in the calendar year 1966 and any subsequent year.

tiplying the number of acres in the farm acreage allotment for wheat by the normal yield of wheat for the farm as determined by the Secretary, and multiplying the resulting number of bushels by the national allocation percentage. If a noncommercial wheat-producing area is established for any marketing year, farms in such area shall be given wheat marketing allocations which are determined by the Secretary to be fair and reasonable in relation to the wheat marketing allocation given producers in the commercial wheat-producing area. (7 U.S.C. 1379b.)

MARKETING CERTIFICATES

Sec. 379c.[89] (a) The Secretary shall provide for the issuance of wheat marketing certificates for each marketing year for which a wheat marketing allocation program is in effect for the purpose of enabling producers on any farm with respect to which certificates are issued to receive, in addition to the other proceeds from the sale of wheat, an amount equal to the value of such certificates. The wheat marketing certificates issued with respect to any farm for any marketing year shall be in the amount of the farm wheat marketing allocation for such year, but not to exceed (i) the actual acreage of wheat planted on the farm for harvest in the calendar year in which the marketing year begin multiplied by the normal yield of wheat for the farm, plus (ii) the amount of wheat stored under section 379c(b) or to avoid or postpone a marketing quota penalty, which is released from storage during the marketing year on account of underplanting or underproduction, and if this limitation operates to reduce the amount of wheat marketing certificates which would otherwise be issued with respect to the farm, such reduction shall be made first from the amount of export certificates which would otherwise be issued. The Secretary shall provide for the sharing of wheat marketing certificates among producers on the farm on the basis of their respective shares in the wheat crop produced on the farm, or the proceeds therefrom. The Secretary shall, in accordance with such regulation as he may prescribe, provide for the issuance of domestic marketing certificates for the portion of the wheat marketing allocation representing wheat used for food products for consumption in the United States and for the issuance of export marketing certificates for the portion of the wheat marketing allocation used for exports. (7 U.S.C. 1379c(a).)

[The italicized language appearing in subsec. (b) is effective only with respect to the crop planted for harvest in the calendar year 1965.]

(b)[90] No producer shall be eligible to receive wheat marketing certificates with respect to any farm for any marketing year in which a marketing quota penalty is assessed for any commodity on such farm

[89] Subsection 379c(a) was amended by Pub. L. 88–279, 78 Stat. 180, approved April 11, 1964, by (1) adding in the second sentence after the words, "(ii) the amount of wheat stored", the language "under section 379c(b) or", (2) by adding at the end of the second sentence the following language, "and if this limitation operates to reduce the amount of wheat marketing certificates which would otherwise be issued with respect to the farm, such reduction shall be made first from the amount of export certificates which would otherwise be issued.", and (3) by adding a new sentence at the end of said subsection.

[90] Subsection 379c(b) was amended by Pub. L. 88–297, 78 Stat. 180, approved April 11, 1964, by adding at the end thereof the italicized portion which begins with the words, "For purposes". However, this italicized portion is effective only with respect to the crop planted for harvest in 1965.

or in which the farm has not complied with the land-use requirements of section 339 to the extent prescribed by the Secretary, or in which, except as the Secretary may by regulation prescribe, the producer exceeds the farm acreage allotment on any other farm for any commodity in which he has an interest as a producer. No producer shall be deemed to have exceeded a farm acreage allotment for wheat if the entire amount of the farm marketing excess is delivered to the Secretary or stored in accordance with applicable regulations to avoid or postpone payment of the penalty. No producer shall be deemed to have exceeded the farm acreage allotment for wheat on any other farm, if such farm is exempt from the farm marketing quota for such crop under section 335. *For purposes of this section, but not for purposes of diversion payments under subsection (b) of section 339, a producer shall be deemed not to have exceeded the farm acreage allotment for wheat if the acreage in excess of the farm acreage allotment does not exceed 50 per centum of the farm acreage allotment and the amount of wheat produced on the acreage in excess of the farm acreage allotment is stored in accordance with regulations issued by the Secretary. The amount of wheat required to be stored hereunder shall be an amount equal to twice the normal yield of wheat per acre established for the farm multiplied by the number of acres of such crop of wheat on the farm in excess of the farm acreage allotment for such crop unless the producer, in accordance with regulations prescribed by the Secretary and within the time prescribed therein, establishes to the satisfaction of the Secretary the actual production of such crop of wheat on the farm. If such actual production is so established, the amount of wheat required to be stored shall be such actual production less the actual production of the farm wheat acreage allotment based upon the average yield per acre for the entire wheat acreage on the farm: Provided however, That the amount of wheat required to be stored shall not be larger than the amount by which the actual production so established exceeds the normal production of the farm wheat acreage allotment. At the time and to the extent of any depletion in the amount of wheat so stored, except depletion resulting from the release of wheat from storage on account of underplanting or underproduction, as provided below or depletion resulting from some cause beyond the control of the producer, the producer shall pay an amount to the Secretary equal to one and one-half times the value of the wheat marketing certificates issued with respect to the farm for the year in which the wheat on the acreage in excess of the allotment was produced. Whenever the planted acreage of the then current crop of wheat on the farm is less than the farm acreage allotment, the total amount of wheat from any previous crops stored hereunder or stored in order to avoid or postpone a marketing quota penalty shall be reduced by that amount which is equal to the normal production of the number of acres by which the farm acreage allotment exceeds the planted acreage, and whenever the actual production of the acreage of wheat is less than the normal production of the farm acreage allotment, the total amount of wheat from any previous crops stored hereunder or in order to avoid a marketing quota penalty shall be reduced by that amount which together with the actual production of the then*

current crop will equal the normal production of the farm acreage allotment. (*7 U.S.C. 1379c*(*b*).)

(c)[91] The Secretary shall determine and proclaim for each marketing year the face value per bushel of wheat marketing certificates. The face value per bushel of domestic certificates shall be the amount by which the level of price support for wheat accompanied by domestic certificates exceeds the level of price support for wheat not accompanied by certificates (noncertificate wheat); and the face value per bushel of export certificates shall be the amount by which the level of price support for wheat accompanied by export certificates exceeds the level of price support for noncertificate wheat. (7 U.S.C. 1379c(c).)

(d) Marketing certificates and transfers thereof shall be represented by such documents, marketing cards, records, accounts, certifications, or other statements or forms as the Secretary may prescribe. (7 U.S.C. 1379c(d).)

MARKETING RESTRICTIONS

SEC. 379d. (a)[92] Marketing certificates shall be transferable only in accordance with regulations prescribed by the Secretary. Any unused certificates legally held by any person shall be purchased by Commodity Credit Corporation if tendered to the Corporation for purchase in accordance with regulations prescribed by the Secretary. (7 U.S.C. 1379d(a).)

(b)[93] During any marketing year for which a wheat marketing allocation program is in effect, (i) all persons engaged in the processing of wheat into food products shall, prior to marketing any such food product or removing such food product for sale or consumption, acquire domestic marketing certificates equivalent to the number of bushels of wheat contained in such product and (ii) all persons exporting wheat shall, prior to such export, acquire export marketing certificates equivalent to the number of bushels so exported. In order to expand international trade in wheat and wheat flour and promote equitable and stable prices therefor the Commodity Credit Corporation shall, upon the exportation from the United States of any wheat or wheat flour, make a refund to the exporter or allow him a credit against the amount payable by him for marketing certificates, in such amount as the Secretary determines will make United States wheat and wheat flour generally competitive in the world market, avoid disruption of world market prices, and fulfill the international obligations of the United States. The Secretary may exempt wheat exported for donation abroad and other noncommercial exports of wheat and wheat processed for use on the farm where grown from the requirements of this subsection. Marketing certificates shall be valid to cover only sales or removals for sale or consumption or exportations made during the marketing year with respect to which they are issued, and after being once used to cover a sale or removal for sale or consump-

[91] Subsection 379c(c) was amended by Pub. L. 88–297, 78 Stat. 181, approved April 11, 1964.
[92] Amended by Pub. L. 88–297, 78 Stat. 181, approved April 11, 1964.
[93] Subsection (b) amended by Pub. L. 88–297, 78 Stat. 181, approved April 11, 1964.

tion or export of a food product or an export of wheat shall be void and shall be disposed of in accordance with regulations prescribed by the Secretary. Notwithstanding the foregoing provisions hereof, the Secretary may require marketing certificates issued for any marketing year to be acquired to cover sales, removals, or exportations made on or after the date during the calendar year in which wheat harvested in such calendar year begins to be marketed as determined by the Secretary even though such wheat is marketed prior to the beginning of the marketing year, and marketing certificates for such marketing year shall be valid to cover sales, removals, or exportations made on or after the date so determined by the Secretary. (7 U.S.C. 1379d(b).)

(c) Upon the giving of a bond or other undertaking satisfactory to the Secretary to secure the purchase of and payment for such marketing certificates as may be required, and subject to such regulations as he may prescribe, any person required to have marketing certificates in order to market or export a commodity may be permitted to market any such commodity without having first acquired marketing certificates. (7 U.S.C. 1379d(c).)

(d)[94] As used in this subtitle, the term "food products" means flour, semolina, farina, bulgur, beverage, and any other product composed wholly or partly of wheat which the Secretary may determine to be a food product. (7 U.S.C. 1379d(d).)

ASSISTANCE IN PURCHASE AND SALE OF MARKETING CERTIFICATES

SEC. 379e. For the purpose of facilitating the purchase and sale of marketing certificates, the Commodity Credit Corporation is authorized to issue, buy, and sell marketing certificates in accordance with regulations prescribed by the Secretary. Such regulations may authorize the Corporation to issue and sell certificates in excess of the quantity of certificates which it purchases. Such regulations may authorize the Corporation in the sale of marketing certificates to charge, in addition to the face value thereof, an amount determined by the Secretary to be appropriate to cover estimated administrative costs in connection with the purchase and sale of the certificates and estimated interest incurred on funds of the Corporation invested in certificates purchased by it. (7 U.S.C. 1379e.)

CONVERSION FACTORS

SEC. 379f. The Secretary shall establish conversion factors which shall be used to determine the amount of wheat contained in any food product. The conversion factor for any such food product shall be determined upon the basis of the weight of wheat used in the manufacture of such product. (7 U.S.C. 1379f.)

AUTHORITY TO FACILITATE TRANSITION

SEC. 379g. The Secretary is authorized to take such action as he determines to be necessary to facilitate the transition from the program currently in effect to the program provided for in this subtitle.

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[94] Amended by Pub. L. 88-297, 78 Stat. 182, approved April 11, 1964.

Notwithstanding any other provision of this subtitle, such authority shall include, but shall not be limited to, the authority to exempt all or a portion of the wheat or food products made therefrom in the channels of trade on the effective date of the program under this subtitle from the marketing restrictions in subsection (b) of section 379d, or to sell certificates to persons owning such wheat or food products at such prices as the Secretary may determine. Any such certificate shall be issued by Commodity Credit Corporation. (7 U.S.C. 1379g.)

REPORTS AND RECORDS

SEC. 379h. This section shall apply to processors of wheat, warehousemen and exporters of wheat and food products, and all persons purchasing, selling, or otherwise dealing in wheat marketing certificates. Any such person shall, from time to time on request of the Secretary, report to the Secretary such information and keep such records as the Secretary finds to be necessary to enable him to carry out the provisions of this subtitle. Such information shall be reported and such records shall be kept in such manner as the Secretary shall prescribe. For the purpose of ascertaining the correctness of any report made or record kept, or of obtaining information required to be furnished in any report, but not so furnished, the Secretary is hereby authorized to examine such books, papers, records, accounts, correspondence, contracts, documents, and memorandums as he has reason to believe are relevant and are within the control of such person. (7 U.S.C. 1379h.)

PENALTIES

SEC. 379i. (a) Any person who violates or attempts to violate or who participates or aids in the violation of any of the provisions of subsection (b) of section 379d of this Act shall forfeit to the United States a sum equal to two times the face value of the marketing certificates involved in such violation. Such forfeiture shall be recoverable in a civil action brought in the name of the United States.

(b) Any person, except a producer in his capacity as a producer, who violates or attempts to violate or who participates or aids in the violation of any provision of this subtitle, or of any regulation, governing the acquisition, disposition, or handling of marketing certificates or who fails to make any report or keep any record as required by section 379h shall be deemed guilty of a misdemeanor and upon conviction thereof shall be subject to a fine of not more than $5,000 for each violation.

(c) Any person who, in his capacity as a producer, knowingly violates or attempts to violate or participates or aids in the violation of any provision of this subtitle, or of any regulation, governing the acquisition, disposition, or handling of marketing certificates or fails to make any report or keep any record as required by section 379h shall, (i) forfeit any right to receive marketing certificates, in whole or in part as the Secretary may determine, with respect to the farm or farms and for the marketing year with respect to which any such act or default is committed, or (ii), if such marketing certificates have

already been issued, pay to the Secretary, upon demand, the amount of the face value of such certificates, or such part thereof as the Secretary may determine. Such determination by the Secretary with respect to the amount of such marketing certificates to be forfeited or the amount to be paid by such producer shall take into consideration the circumstances relating to the act or default committed and the seriousness of such act or default.

(d) Any person who falsely makes, issues, alters, forges, or counterfeits any marketing certificate, or with fraudulent intent possesses, transfers, or uses any such falsely made, issued, altered, forged, or counterfeited marketing certificate, shall be deemed guilty of a felony and upon conviction thereof shall be subject to a fine of not more than $10,000 or imprisonment of not more than ten years, or both. (7 U.S.C. 1379i.)

REGULATIONS

Sec. 379j. The Secretary shall prescribe such regulations as may be necessary to carry out the provisions of this subtitle including but not limited to regulations governing the acquisition, disposition, or handling of marketing certificates. (7 U.S.C. 1379j.)

Subtitle E.—Rice Certificates

LEGISLATIVE FINDINGS

Sec 380a. to Sec. 380p. Applicable only to 1956, 1957 and 1958 crops of rice.

Subtitle F—Miscellaneous Provisions and Appropriations

Part I—Miscellaneous

COTTON PRICE ADJUSTMENT PAYMENTS

Sec. 381. (a) (Applicable only to 1937 crop of cotton.)
(b) (Applicable only to 1937 crop of cotton.)
(c)[95] * * *
Sec. 382. (Applicable only to 1937 crop of cotton.)

INSURANCE OF COTTON AND RECONCENTRATION OF COTTON

Sec. 383. (a) The Commodity Credit Corporation shall place all insurance of every nature taken out by it on cotton, and all renewals, extensions, or continuations of existing insurance, with insurance agents who are bona fide residents of and doing business in the State where the cotton is warehoused: *Provided*, That such insurance may be secured at a cost not greater than similar insurance offered on said cotton elsewhere. (7 U.S.C. 1383(a).)

(b) Cotton held as security for any loan heretofore or hereafter made or arranged for by the Commodity Credit Corporation shall not hereafter be reconcentrated without the written consent of the producer or borrower. (7 U.S.C. 1383(b).)

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[95] Repealed by Pub. L. 987, 80th Cong., 62 Stat. 1255, approved July 3, 1948.

[ACT OF JUNE 16, 1938.[96]—In the administration of section 383(b) of the Agricultural Adjustment Act of 1938 the written consent of the producer or borrower to the reconcentration of any cotton held as security for any loan heretofore or hereafter made or arranged for by the Commodity Credit Corporation shall not be deemed to have been given unless such consent shall have been given in an instrument made solely for that purpose. Notwithstanding any provision of any loan agreement heretofore made, no cotton held under any such agreement as security for any such loan shall be moved from one warehouse to another unless the written consent of the producer or borrower shall have been obtained in a separate instrument given solely for that purpose, as required by this Act. The giving of written consent for the reconcentration of cotton shall not be made a condition upon the making of any loan hereafter made or arranged for by the Commodity Credit Corporation: *Provided, however*, That in cases where there is congestion and lack of storage facilities, and the local warehouse certifies such fact and requests the Commodity Credit Corporation to move the cotton for reconcentration to some other point, or when the Commodity Credit Corporation determines such loan cotton is improperly warehoused and subject to damage, or if uninsured, or if any of the terms of the loan agreement are violated, or if carrying charges are substantially in excess of the average of carrying charges available elsewhere, and the local warehouse, after notice, declines to reduce such charges, such written consent as provided in this amendment need not be obtained; and consent to movement under any of the conditions of this proviso may be required in future loan agreements. (7 U.S.C. 1383a.)]

REPORT OF BENEFITS

SEC. 384.[97] * * *

FINALITY OF FARMERS' PAYMENTS AND LOANS

SEC. 385.[98] The facts constituting the basis for any Soil Conservation Act payment, parity payment, payment under section 339, loan, or price support operation, or the amount thereof, when officially determined in conformity with the applicable regulations prescribed by the Secretary or by the Commodity Credit Corporation, shall be final and conclusive and shall not be reviewable by any other officer or agency of the Government. In case any person who is entitled to any such payment dies, becomes incompetent, or disappears before receiving such payment, or is succeeded by another who renders or completes the required performance, the payment shall, without regard to any other provisions of law, be made as the Secretary of Agriculture may determine to be fair and reasonable in all the circumstances and provided by regulations. This section also shall be applicable to payments provided for under section 348 of this title. (7 U.S.C. 1385.)

SEC. 386. The provisions of section 3741 of the Revised Statutes (U.S.C., 1934 edition, title 41, sec. 22) and sections 114 and 115 of the Criminal Code of the United States (U.S.C., 1934 edition, title

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[96] Pub. L. 660, 75th Cong., 52 Stat. 762, approved June 16, 1938.
[97] Repealed by Pub. L. 615, 79th Cong., 60 Stat. 866, approved August 7, 1946.
[98] The last sentence in section 385 was added by Pub. L. 88–297, 78 Stat. 174, approved April 11, 1964.

18, secs. 204 and 205) [now 18 U.S.C. 431 and 432] shall not be applicable to loans or payments made under this Act (except under section 383(a)). (7 U.S.C. 1386.)

PHOTOGRAPHIC REPRODUCTIONS AND MAPS

SEC. 387. The Secretary may furnish reproductions of such aerial or other photographs, mosaics, and maps as have been obtained in connection with the authorized work of the Department to farmers and governmental agencies at the estimated cost of furnishing such reproductions, and to persons other than farmers at such prices (not less than estimated cost of furnishing such reproductions) as the Secretary may determine, the money received from such sales to be deposited in the Treasury to the credit of the appropriation charged with the cost of making such reproductions. This section shall not affect the power of the Secretary to make other disposition of such or similar materials under any other provisions of existing law. (7 U.S.C. 1387.)

UTILIZATION OF LOCAL AGENCIES

SEC. 388. (a) The provisions of section 8(b) and section 11 of the Soil Conservation and Domestic Allotment Act, as amended, relating to the utilization of State, county, local committees, the extension service, and other approved agencies, and to recognition and encouragement of cooperative associations, shall apply in the administration of this Act; and the Secretary shall, for such purposes, utilize the same local, county, and State committees as are utilized under sections 7 to 17, inclusive, of the Soil Conservation and Domestic Allotment Act, as amended. The local administrative areas designated under section 8(b) of the Soil Conservation and Domestic Allotment Act, as amended, for the administration of programs under that Act, and the local administrative areas designated for the administration of this Act shall be the same. (7 U.S.C. 1388(a).)

(b) The Secretary is authorized and directed, from any funds made available for the purposes of the Acts in connection with which county committees are utilized, to make payments to county committees of farmers to cover the estimated administrative expenses incurred or to be incurred by them in cooperating in carrying out the provisions of such Acts. All or part of such estimated administrative expenses of any such committee may be deducted pro rata from the Soil Conservation Act payments, parity payments, or loans, or other payments under such Acts, made unless payment of such expenses is otherwise provided by law. The Secretary may make such payments to such committees in advance of determination of performance by farmers. (7 U.S.C. 1388(b).)

PERSONNEL

SEC. 389. The Secretary is authorized and directed to provide for the execution by the Agricultural Adjustment Administration of such of the powers conferred upon him by this Act as he deems may be appropriately exercised by such administration; and for such purposes the provisions of law applicable to appointment and compensation of

persons employed by the Agricultural Adjustment Administration shall apply. (7 U.S.C. 1389.) [99]

SEPARABILITY

SEC. 390. If any provision of this Act, or the application thereof to any person or circumstance, is held invalid, the validity of the remainder of the Act and the application of such provision to other persons or circumstances, and the provisions of the Soil Conservation and Domestic Allotment Act, as amended, shall not be affected thereby. Without limiting the generality of the foregoing, if any provision of this Act should be held not to be within the power of the Congress to regulate interstate and foreign commerce, such provision shall not be held invalid if it is within the power of the Congress to provide for the general welfare or any other power of the Congress. If any provision of this Act for the marketing quotas with respect to any commodity should be held invalid, no provision of this Act for marketing quotas with respect to any other commodity shall be affected thereby. If the application of any provision for a referendum should be held invalid, the application of other provisions shall not be affected thereby. If by reason of any provision for a referendum the application of any such other provision to any person or circumstance is held invalid, the application of such other provision to other persons or circumstances shall not be affected thereby. (7 U.S.C. 1390.)

PART II—APPROPRIATIONS AND ADMINISTRATIVE EXPENSES

APPROPRIATIONS

SEC. 391. (a) Beginning with the fiscal year ending June 30, 1938, there is hereby authorized to be appropriated, for each fiscal year for the administration of this Act and for the making of soil conservation and other payments such sums as Congress may determine, in addition to any amount made available pursuant to section 15 of the Soil Conservation and Domestic Allotment Act, as amended. (7 U.S.C. 1391(a).)

(b) (Applicable only to fiscal year 1938.)

(c) During each fiscal year, beginning with the fiscal year ending June 30, 1941, the Commodity Credit Corporation is authorized and directed to loan to the Secretary such sums, not to exceed $50,000,000, as he estimates will be required during such fiscal year, to make crop insurance premium advances and to make advances pursuant to the applicable provisions of sections 8 and 12 of the Soil Conservation and Domestic Allotment Act, as amended, in connection with programs applicable to crops harvested in the calendar year in which such fiscal year ends, and to pay the administrative expenses of county agricultural conservation associations for the calendar year in which such fiscal year ends. The sums so loaned during any fis-

[99] The functions of the Agricultural Adjustment Administration were transferred to the Secretary of Agriculture by 1946 Reorganization Plan No. 3 (60 Stat. 1100, 11 F.R. 7877), and delegated by him to the Commodity Stabilization Service (19 F.R. 77). The title of the Commodity Stabilization Service was changed to Agricultural Stabilization and Conservation Service (Reorganization Plan 2 of 1953, (26 F.R. 8404)).

cal year shall be transferred to the current appropriation available for carrying out sections 7 to 17 of such Act and shall be repaid, with interest at a rate to be determined by the Secretary but not less than the cost of money to the Commodity Credit Corporation for a comparable period, during the succeeding fiscal year from the appropriation available for that year or from any unobligated balance of the appropriation for any other year. (7 U.S.C. 1391(c).)

ADMINISTRATIVE EXPENSES

SEC. 392. (a) The Secretary is authorized and directed to make such expenditures as he deems necessary to carry out the provisions of this Act and sections 7 to 17, inclusive, of the Soil Conservation and Domestic Allotment Act, as amended, including personal services and rents in the District of Columbia and elsewhere; traveling expenses; supplies and equipment; lawbooks, books of reference, directories, periodicals, and newspapers; and the preparation and display of exhibits, including such displays at community, county, State, interstate, and international fairs within the United States. The Secretary of the Treasury is authorized and directed upon the request of the Secretary to establish one or more separate appropriation accounts into which there shall be transferred from the respective funds available for the purposes of the several Acts, in connection with which personnel or other facilities of the Agricultural Adjustment Administration are utilized, proportionate amounts estimated by the Secretary to be required by the Agricultural Adjustment Administration for administrative expenses in carrying out or cooperating in carrying out any of the provisions of the respective Acts. (7 U.S.C. 1392(a).)

(b) In the administration of this title and sections 7 to 17, inclusive, of the Soil Conservation and Domestic Allotment Act, as amended, the aggregate amount expended in any fiscal year, beginning with the fiscal year ending June 30, 1942, for administrative expenses in the District of Columbia, including regional offices, and in the several States (not including the expenses of county and local committees) shall not exceed 3 per centum of the total amount available for such fiscal year for carrying out the purposes of this title and such Act, unless otherwise provided by appropriation or other law. In the administration of section 32 of the Act entitled "An Act to amend the Agricultural Adjustment Act, and for other purposes," approved August 24, 1935 (49 Stat. 774), as amended, and the Agricultural Marketing Agreement Act of 1937, as amended, and those sections of the Agricultural Adjustment Act (of 1933), as amended, which were reenacted and amended by the Agricultural Marketing Agreement Act of 1937, as amended, the aggregate amount expended in any fiscal year, beginning with the fiscal year ending June 30, 1942, for administrative expenses in the District of Columbia, including regional offices, and in the several States (not including the expenses of county and local committees) shall not exceed 4 per centum of the total amount available for such fiscal year for carrying out the purposes of said Acts, unless otherwise provided by appropriation or other law. In the event any administrative expenses of any county or local committee are deducted

in any fiscal year, beginning with the fiscal year ending June 30, 1939, from Soil Conservation Act payments, parity payments, or loans, each farmer receiving benefits under such provisions shall be apprised of the amount or percentage deducted from such benefit payment or loan on account of such administrative expenses. The names and addresses of the members and employees of any county or local committee, and the amount of such compensation received by each of them, shall be posted annually in a conspicuous place in the area within which they are employed. (7 U.S.C. 1392(b).)

ALLOTMENT OF APPROPRIATIONS

SEC. 393. All funds for carrying out the provisions of this Act shall be available for allotment to bureaus and offices of the Department, and for transfer to such other agencies of the Federal Government, and to such State agencies, as the Secretary may request to cooperate or assist in carrying out the provisions of this Act. (7 U.S.C. 1393.)

TITLE IV—COTTON POOL PARTICIPATION TRUST CERTIFICATES

[The provisions of this title have not been repealed but are no longer applicable. (7 U.S.C. 1401–1407.)]

TITLE V—FEDERAL CROP INSURANCE ACT

[This title appears in Part V of this compilation.]

PART III

SOIL BANK ACT [1]

SHORT TITLE

SEC. 101. This title may be cited as the "Soil Bank Act". (7 U.S.C. 1801 note.)

DECLARATION OF POLICY

SEC. 102. The Congress hereby finds that the production of excessive supplies of agricultural commodities depresses the prices and income of farm families; constitutes improper land use and brings about soil erosion, depletion of soil fertility, and too rapid release of water from lands where it falls, thereby adversely affecting the national welfare, impairing the productive facilities necessary for a continuous and stable supply of agricultural commodities, and endangering an adequate supply of water for agricultural and nonagricultural use; overtaxes the facilities of interstate and foreign transportation; congests terminal markets and handling and processing centers in the flow of commodities from producers to consumers; depresses prices in interstate and foreign commerce; disrupts the orderly marketing of commodities in such commerce; and otherwise affects, burdens, and obstructs interstate and foreign commerce. It is in the interest of the general welfare that the soil and water resources of the Nation be not wasted and depleted in the production of such burdensome surpluses and that interstate and foreign commerce in agricultural commodities be protected from excessive supplies. It is hereby declared to be the policy of the Congress and the purposes of this title to protect and increase farm income, to protect the national soil, water, and forest and wildlife resources from waste and depletion, to protect interstate and foreign commerce from the burdens and obstructions which result from the utilization of farmland for the production of excessive supplies of agricultural commodities, and to provide for the conservation of such resources and an adequate, balanced, and orderly flow of such agricultural commodities in interstate and foreign commerce. To effectuate the policy of Congress and the purposes of this title programs are herein authorized to assist farmers to divert a portion of their cropland from the production of excessive supplies of agricultural commodities, and to carry out a program of soil, water, forest and wildlife conservation. The activities authorized under this title are supplementary to the acreage allotments and marketing quotas authorized under the Agricultural Adjustment Act of 1938, as amended, and together with such acreage allotments and marketing quotas, constitute an over-all program to prevent excessive supplies of agricultural commodities from burdening and obstructing interstate and foreign commerce. (7 U.S.C. 1801.)

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[1] Approved May 28, 1956, 70 Stat. 188, as Title I of the Agricultural Act of 1956.

Subtitle A—Acreage Reserve Program

TERMS AND CONDITIONS

Sec. 103. (a) Notwithstanding any other provision of law, the Secretary of Agriculture (hereinafter referred to as the "Secretary") is authorized and directed to formulate and carry out an acreage reserve program for the 1956, 1957, 1958, and 1959 [2] crops of wheat,[3] cotton, corn produced in the commercial corn-producing area, peanuts, rice, flue-cured tobacco, burley tobacco, Maryland tobacco, dark air-cured tobacco, fire-cured tobacco, Virginia sun-cured tobacco, cigar binder tobacco types 51, 52, 54, and 55, Ohio cigar filler tobacco types 42, 43, and 44, respectively (hereinafter referred to as "the commodity"), under which producers shall be compensated for reducing their acreages of the commodity below their farm acreage allotments or their farm base acreages, whichever may be applicable. To be eligible for such compensation the producer (1) shall reduce his acreage of the commodity below his farm acreage allotment or farm base acreage, whichever may be applicable, within such limits as the Secretary may prescribe, (2) shall specifically designate the acreage so withdrawn from the production of such commodity (hereinafter referred to as the "reserve acreage"), and (3) shall not harvest any crop from, or graze, the reserve acreage unless the Secretary, after certification by the Governor of the State in which such acreage is situated of the need for grazing on such acreage, determines that it is necessary to permit grazing thereon in order to alleviate damage, hardship, or suffering caused by severe drought, flood, or other natural disaster, and consents to such grazing. Reserve acreage of a commodity may include acreage whether or not planted to the production of the 1956 crop of the commodity prior to the announcement of the acreage reserve program for the 1956 crop if the crop thereon, if any, shall be plowed under or otherwise physically incorporated into the soil, or clipped, mowed, or cut to prevent maturing so that the reduction in acreage of the commodity below the acreage allotment occurs not later than 21 days after the enactment of this title, or by such later date as may be fixed by the Secretary. The reserve acreage shall be in addition to any acreage devoted to the conservation reserve program authorized under subtitle B of this title. The acreage reserve program may include such terms and conditions, in addition to those specifically provided for herein, including provisions relating to control of noxious weeds on the reserve acreage, as the Secretary determines are desirable to effectuate the purposes of this title and to facilitate the practical administration of the acreage reserve program.

Before any producer is entitled to receive any compensation for participating in the acreage reserve program, he must first enter into a contract with the Secretary, which contract, in addition to such

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[2] See 1959 Agriculture Appropriation Act, 72 Stat. 188, approved July 13, 1958, which prohibited any expenditure thereunder for an acreage reserve program for 1959 crops.

[3] The Act of April 2, 1957, 71 Stat. 10, and the Act of May 1, 1958, 72 Stat. 101, amended section 334 of the Agricultural Adjustment Act of 1938 to add provisions relating to participation in the acreage reserve program by producers receiving increased allotments for durum wheat.

other terms and conditions as may be prescribed by the Secretary, shall contain provisions by which such producer shall agree:

(i) In the event that the Secretary determines that there has been a violation of the contract at any stage during the time such producer has control of the farm and that such violation is of such a substantial nature as to warrant termination of the contract, to forfeit all rights to payments or grants under the contract, and to refund to the United States all payments and grants received by him thereunder: *Provided, however*, That the provisions of Section 107(d) shall apply to the termination of any contract hereunder.

(ii) In the event that the Secretary determines that there has been a violation of the contract but that such violation is of such a nature as not to warrant termination of the contract, to accept such payment adjustments, forfeit such benefits, and make such refunds to the United States of payments and benefits received by him, under the contract, as the Secretary may determine to be appropriate. (7 U.S.C. 1821(a).)

(b) (1) There is hereby established for 1956 and for each year for which an acreage reserve program is in effect for corn a total base acreage of corn for the commercial corn-producing area proclaimed under section 327 of the Agricultural Adjustment Act of 1938, as amended, of fifty-one million acres. The total base acreage of corn for the commercial corn-producing area shall be apportioned by the Secretary among the counties in such area on the basis of the acreage of corn in such counties during the five calendar years immediately preceding the calendar year in which the apportionment is made (plus, in applicable years, the acreage diverted under previous agricultural adjustment, conservation, and soil bank programs), with adjustments for abnormal weather conditions, for trends in acreage during such period and for the promotion of soil-conservation practices: *Provided*, That any downward adjustment for the promotion of soil-conservation practices shall not exceed 2 per centum of the total base acreage that would otherwise be apportioned to the county. The base acreage for the county shall be apportioned by the Secretary, through the local committees, among the farms within the county on the basis of past acreage of corn (planted and diverted), tillable acreage crop-rotation practices, types of soil, and topography.

(2) This subsection (b) shall become inoperative after 1956 if in the referendum conducted pursuant to section 308(b), producers do not vote in favor of the program provided in subsection (c) of such section.[4] (7 U.S.C. 1821(b).)

EXTENT OF PARTICIPATION IN PROGRAM

SEC. 104. For purposes of the acreage reserve program the Secretary shall establish a national reserve acreage goal for the 1956, 1957, 1958, and 1959 crops of each commodity specified in section 103(a). The limits within which individual farms may participate in the acreage reserve program shall be established in such manner as the Secretary

[4] Corn producers voted against the price support program provided in sec. 308(c) of the Agricultural Act of 1956.

determines is reasonably calculated to achieve the national reserve acreage goal and give producers a fair and equitable opportunity to participate in the acreage reserve program, taking into consideration their acreage allotments or farm base acreages, whichever may be applicable, the supply and demand conditions for different classes, grades, and qualities of the commodity, and such other factors as he deems appropriate. (7 U.S.C. 1822.)

COMPENSATION OF PRODUCERS

Sec. 105. (a) Producers shall be compensated for participating in the acreage reserve program through the issuance of negotiable certificates which the Commodity Credit Corporation shall redeem in accordance with regulations prescribed by the Secretary (1) in cash upon presentation by the producer or by any holder in due course or (2) at the option of the producer in the case of certificates issued with respect to grains and upon presentation by him, in grains (such grains to be valued by the Secretary at such levels as he determines will not materially impair the market price for such grain yet will, to the maximum extent practicable encourage acceptance of payment in grains in lieu of cash): *Provided*, That disposition of quantities of stocks hereunder in any one year shall be limited to not more than two-thirds of such quantities of such commodities as the Secretary determines would be a reasonable estimate of what would have been produced for marketing during such marketing year on the acreage withheld from production under the provisions of this title: *And provided further*, That such stocks shall not be released prior to the end of the normal harvesting season for the particular commodity being released. Compensation under this section shall be at such rate or rates as the Secretary determines will provide producers with a fair and reasonable return for reducing their acreage of the commodity, taking into consideration the loss of production of the commodity on the reserve acreage, any savings in cost which result from not planting the commodity on the reserve acreage, and the incentive necessary to achieve the reserve acreage goal. The Secretary shall make an adjustment in yields for drought, flood, or other abnormal conditions in estimating the loss of production for purposes of establishing rates of compensation. The rates of payment offered under this section shall be such as to encourage producers to underplant their allotments more than one year. Commodities delivered to producers in redemption of such certificates shall not be eligible for tender to Commodity Credit Corporation under the price support program. (7 U.S.C. 1823(a).)

(b) Compensation shall be paid to any producer for participating in the acreage reserve program for any year including 1956 when the Secretary has ascertained that such producer has complied with the acreage reduction requirements of such program for such year. (7 U.S.C. 1823(b).)

(c) The total compensation paid producers for participating in the acreage reserve program with respect to any year's crops shall not exceed $750,000,000, and with respect to any commodity for any year shall not exceed the amount shown below: Wheat, $375,000,000; cotton, $300,000,000; corn in the commercial corn-producing area,

$300,000,000; peanuts, $7,000,000; rice, $23,000,000; and tobacco, $45,000,000. The total amount available for the acreage reserve program for any year's crops shall be apportioned among the various commodities on the basis of the amounts required to achieve the reserve acreage goal for each commodity established under section 104. (7 U.S.C. 1823(c).)

EFFECT ON ACREAGE ALLOTMENTS AND QUOTAS

SEC. 106. (a) In the future establishment of State, county, and farm acreage allotments under the Agricultural Adjustment Act of 1938, as amended, or base acreages under this title, reserve acreages applicable to any commodity shall be credited to the State, county, and farm as though such acreage had actually been devoted to the production of the commodity. (7 U.S.C. 1824(a).)

(b) In applying the provisions of paragraph (6) of Public Law 74, Seventy-seventh Congress (7 U.S.C. 1340(6)), and sections 326(b) and 356(g) of the Agricultural Adjustment Act of 1938, as amended (7 U.S.C. 1326(b), 1356(g)), relating to reduction of the storage amounts of wheat and rice, the reserve acreage of the commodity on any farm shall be regarded as wheat acreage or rice acreage, as the case may be, on the farm. (7 U.S.C. 1824(b).)

SUBTITLE B—CONSERVATION RESERVE PROGRAM

TERMS AND CONDITIONS

SEC. 107. (a) To effectuate the purposes of this title the Secretary is hereby authorized to enter into contracts for periods of not less than three years with producers determined by him to have control for the contract period of the farms covered by the contract wherein the producer shall agree:

(1) To establish and maintain for the contract period protective vegetative cover (including but not limited to grass and trees), water storage facilities, or other soil-, water-, wildlife-, or forest-conserving uses on a specifically designated acreage of land on the farm regularly used in the production of crops (including crops, such as tame hay, alfalfa, and clovers, which do not require annual tillage).

(2) To devote to conserving crops or uses, or allow to remain idle, throughout the contract period an acreage of the remaining land on the farm which is not less than the acreage normally devoted only to conserving crops or uses or normally allowed to remain idle on such remaining acreage.

(3) Not to harvest any crop from the acreage established in protective vegetative cover, excepting timber (in accordance with sound forestry management) and wildlife or other natural products of such acreage which do not increase supplies of feed for domestic animals, and except that the Secretary may, with the approval of the contract signers, permit hay to be removed from such acreage if the Secretary, after certification by the Governor of the State in which such acreage is situated of the need for removal of hay from such acreage, determines that it is necessary to permit removal of hay from such acreage

in order to alleviate damage, hardship, or suffering caused by severe drought, flood, or other natural disaster.[5]

(4) Not to graze any acreage established in protective vegetative cover prior to January 1, 1959, or such later date as may be provided in the contract, except pursuant to the provisions of section 103(a) (3) hereof; and if such acreage is grazed at the end of such period, to graze such acreage during the remainder of the period covered by the contract in accordance with sound pasture management.

(5) Not to adopt any practice, or divert lands on the farm from conservation, woods, grazing, or other use, to any use specified by the Secretary in the contract as a practice or use which would tend to defeat the purposes of the contract.

(6) (A) In the event that the Secretary determines that there has been a violation of the contract (including the prohibition of grazing on conservation acreages) at any stage during the time such producer has control of the farm and that such violation is of such a substantial nature as to warrant termintion of the contract, to forfeit all rights to payments or grants under the contract, and to refund to the United States all payments and grants received by him thereunder.

(B) In the event that the Secretary determines that there has been a violation of the contract but that such violation is of such a nature as not to warrant termination of the contract, to accept such payment adjustments, forfeit such benefits, and make such refunds to the United States of payments and benefits received by him, under the contract, as the Secretary may determine to be apropriate.

(7) To such additional provisions as the Secretary determines are desirable and includes in the contract to effectuate the purposes of this title and to facilitate the practical administration of the conservation reserve program, including provisions relating to control of noxious weeds. (7 U.S.C. 1831(a).)

(b) In return for such agreement by the producer the Secretary shall agree:

(1) To bear such part of the cost (including labor) of establishing and maintaining vegetative cover or water storage facilities, or other soil-, water-, wildlife-, or forest-conserving uses, on the designated acreage as the Secretary determines to be necessary to effectuate the purposes of this title, but not to exceed a maximum amount per acre or facility prescribed by the Secretary for the county or area in which the farm is situated; and

(2) To make an annual payment to the producer for the term of the contract upon determination that he has fulfilled the provisions of the contract entitling him to such payment. The rate or rates of the annual payment to be provided for in the contracts shall be established on such basis as the Secretary determines will provide producers with a fair and reasonable annual return on the land established in protective vegetative cover or water storage facilities, or other soil-, water-, wildlife-, or forest-conserving uses, taking into consideration the value of the land for the production of commodities customarily grown on such kind of land in the county or area, the prevailing rates

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[5] Amended by the Act of July 3, 1962, 76 Stat. 135, and effective from the date of enactment to replace an identical amendment by the Act of June 9, 1961, 75 Stat. 129, which expired by its own terms on June 29, 1962.

for cash rentals for similar land in the county or area, the incentive necessary to obtain contracts covering sufficient acreage for the substantial accomplishment of the purposes of the conservation reserve program, and such other factors as he deems appropriate.[6] Such rate or rates may be determined on an individual farm basis, a county or area basis, or such other basis as the Secretary determines will facilitate the practical administration of the program. (7 U.S.C. 1831(b).)

(c) In determining the lands in any area to be covered by contracts entered into under this section, the Secretary may use advertising and bid procedure if he determines that such action will contribute to the effective and equitable administration of the conservation reserve program. (7 U.S.C. 1831(c).)

(d) A contract shall not be terminated under paragraph (6) of subsection (a) unless the nature of the violation is such as to defeat or substantially impair the purposes of the contract. Whenever the State committee believes that there has been a violation which would warrant termination of a contract, the producer shall be given written notice thereof by registered mail or certified mail [7] or personal service, and the producer shall, if he requests such an opportunity within thirty days after the delivery or service of such notice, be given an opportunity to show cause, in an informal proceeding before the county committee under regulations promulgated by the Secretary, why the contract should not be terminated. If the producer does not request an opportunity to show cause why the contract should not be terminated within such thirty-day period, the determination of the State committee made in accordance with regulations of the Secretary shall be final and conclusive. If the producer within such thirty-day period requests an opportunity to show cause why the contract should not be terminated, the county committee, at the conclusion of the proceeding, shall submit a report, including its recommendations, to the State committee for determination, on the basis of such report and such other information as is available to the State committee, as to whether there has been a violation which would warrant termination of the contract. The producer shall be accorded the right, in accordance with regulations promulgated by the Secretary, to appear before the State committee in connection with the State committee's determination of the issue. The producer shall be given written notice by registered or certified mail [7] or personal service of the State committee's determination. If the producer feels aggrieved by such determination, he may obtain judicial review of such determination by filing a complaint with the United States district court for the district in which the land covered by the contract is located, within ninety days after the delivery or service of notice of such determination, requesting the court to set aside such determination. Service of process in such action shall be made in accordance with the rule of service of process upon the United States prescribed by the Rules of Civil Procedure for the United States District Courts. The copy of the summons and complaint required to be delivered to the officer or agency whose

[6] See 1960 Agriculture Appropriation Act, 73 Stat. 167, approved July 8, 1959, as amended by the Act of September 21, 1959, 73 Stat. 606, which contains limitations on payments to producers under the Conservation Reserve Program.

[7] The phrase "or certified mail" was added by the Act of June 11, 1960, 74 Stat. 200.

order is being attacked shall be sent to the chairman of the State committee. The action in the United States district court shall be a trial de novo to determine whether there has been a violation which would warrant termination of the contract. If the producer does not seek judicial review of the State committee's determination within the ninety-day period allowed therefor, the State committee's determination shall be final and conclusive. The terms "county committee" and "State committee" as used herein refer to the county and State committees established under section 8 of the Soil Conservation and Domestic Allotment Act, as amended. (7 U.S.C. 1831(d).)

CONSERVATION RESERVE GOAL

SEC. 108. (a) The Secretary shall not later than February 1 of each year determine and announce the national conservation reserve goal for such year. Such goal shall be that percentage which the Secretary determines it is practicable to cover by contracts during such year of the number of acres, if any, by which (1) the acreage used for the production of agricultural commodities during the year preceding the year for which such determination is made, plus any acreage then in the acreage or conservation reserve program or retired from production as a result of acreage allotments or marketing quotas, exceeds (2) the acreage needed during the year for which such determination is made for the production of agricultural commodities for domestic consumption and export and an adequate allowance for carryover. As soon as practicable after the enactment of this title the Secretary shall determine the national conservation acreage goal for 1956. (7 U.S.C. 1832(a).)

(b) In distributing the national acreage goal among the various States and major crop production regions, the Secretary shall give due regard to the respective needs of the various States and regions for flood control, drought control, and other conservation benefits; the desires of producers in particular States or regions to participate in the conservation program; the diversion of acreage from crops under acreage allotments or marketing quotas; and the need to assure adequate production of agricultural commodities and products not in surplus and to discourage the production of agricultural commodities and products in surplus. (7 U.S.C. 1832 (b).)

(c) The Secretary shall transmit to the Congress on or before March 15 of each year a report of the scope of the conservation reserve program for the preceding year and the basis for participation in such program in the various States and major crop production regions of the country. (7 U.S.C. 1832(c).)

AUTHORIZED PERIOD OF CONTRACTS AND EXPENDITURES

SEC. 109. (a) The Secretary is authorized to formulate and announce programs under this subtitle B and to enter into contracts thereunder with producers during the five-year period 1956–1960 to be carried out during the period ending not later than December 31,

1969, except that contracts for the establishment of tree cover may continue until December 31, 1974. (7 U.S.C. 1833(a).)

(b) The period covered by any contract shall not exceed ten years, except that contracts for the establishment of tree cover may extend for 15 years. (7 U.S.C. 1833(b).)

(c) In carrying out the conservation reserve program, the Secretary shall not enter into contracts with producers which would require payments to producers, including the cost of materials and services, in excess of $450,000,000 in any calendar year. (7 U.S.C. 1833(c).)

TERMINATION AND MODIFICATION OF CONTRACTS

SEC. 110. (a) The Secretary may treminate any contract with a producer by mutual agreement with the producer if the Secretary determines that such termination would be in the public interest. (7 U.S.C. 1834(a).)

(b) The Secretary may agree to such modification of contracts previously entered into as he may determine to be desirable to carry out the purposes of this title and to facilitate the practicable administration of the conservation reserve program. (7 U.S.C. 1834(b).)

CONSERVATION MATERIALS AND SERVICES

SEC. 111. (a) The Secretary may purchase or produce conservation materials and services and make such materials and services available to producers under the conservation reserve program to aid them in establishing vegetative cover or water storage facilities, or other soil-, water-, wildlife-, or forest-conserving uses, under contracts authorized by this subtitle B, may reimburse any Federal, State, or local government agency for conservation materials and services furnished by such agency, and may pay expenses necessary in making such materials, and services available, including all or part of the cost incident to the delivery, application, or installation of materials and services.[8] (7 U.S.C. 1835(a).)

(b) Notwithstanding any other provision of law, in making conservation materials and services available to producers hereunder, the Secretary may make payments, in advance of determination of performance by the producers, to persons who fill purchase orders covering approved conservation materials or who render services to the Secretary in furnishing to producers approved conservation materials or services for the establishment by the producers of vegetative cover or water storage facilities, or other soil-, water-, wildlife-, or forest-conserving uses, under contracts authorized by this subtitle B. The price at which purchase orders for any conservation material or service are filled may be limited, if the Secretary determines that it is necessary in the interest of producers and the Government, to a fair price fixed in accordance with regulations prescribed by the Secretary. (7 U.S.C. 1835(b).)

[8] See Act of June 25, 1962, 76 Stat. 107, providing for the continuation of the program of production of tree planting stock which was initiated and pursued under the Soil Bank Act but since discontinued under the Soil Bank Act.

EFFECT ON OTHER PROGRAMS

SEC. 112. Notwithstanding any other provision of law—

(1) insofar as the acreage of cropland on any farm enters into the determination of acreage allotments and marketing quotas under the Agricultural Adjustment Act of 1938, as amended, the cropland acreage on the farm shall not be decreased during the period of any contract heretofore or hereafter entered into under this subtitle by reason of any action taken for the purpose of carrying out such contract and, under regulations of the Secretary, shall not be decreased, for such period after the expiration of the contract as is equal to the period of the contract, by reason of the maintenance of any change in land use from cultivated cropland to permanent vegetation carried out under the contract;

(2) the acreage on any farm which is determined under regulations of the Secretary to have been diverted from the production of any commodity subject to acreage allotments or marketing quotas in order to carry out any contract heretofore or hereafter entered into under this subtitle or in order to maintain, for such period after the expiration of the contract as is equal to the period of the contract, any change in land use from cultivated cropland to permanent vegetation carried out under the contract shall be considered acreage devoted to the commodity for the purposes of establishing future State, county, and farm acreage allotments under the Agricultural Adjustment Act of 1938, as amended.[9] (7 U.S.C. 1836.)

GEOGRAPHICAL APPLICABILITY

SEC. 113. This subtitle B shall apply to the several States and, if the Secretary determines it to be in the national interest, to the Commonwealth of Puerto Rico, and the Virgin Islands; and as used in this subtitle B, the term "State" includes Puerto Rico and the Virgin Islands.[10] (7 U.S.C. 1837.)

SUBTITLE C—GENERAL PROVISIONS

COMPLIANCE WITH ACREAGE ALLOTMENTS

SEC. 114. No person shall be eligible for payments or compensation under this title with respect to any farm for any year in which (1) the acreage of any basic agricultural commodity other than wheat or corn on the farm exceeds the farm acreage allotment for the commodity under title III of the Agricultural Adjustment Act of 1938, as amended, or (2) in the case of a farm which is not exempted from marketing quota penalties under section 335(f) of the Agricultural Adjustment Act of 1938, as amended, the wheat acreage on the farm exceeds the larger of the farm wheat acreage allotment under such title or fifteen acres, or[11] (3) the corn acreage on the farm, in the

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[9] Amended by Act of September 14, 1960, 74 Stat. 1030.
[10] Amended by Act of July 12, 1960, 74 Stat. 411.
[11] Subdivision (2) of Sec. 114 amended by Act of August 28, 1957, 71 Stat. 478.

case of a farm in the commercial corn-producing area, exceeds the farm base acreage for corn or the farm acreage allotment, whichever is in effect. For the purpose of this section, a producer shall not be deemed to have exceeded his farm acreage allotment or farm base acreage, unless such producer knowingly exceeded such allotment or base acreage and, in the case of wheat, unless such producer knowingly exceeded the farm acreage allotment or fifteen acres, whichever is larger.

Notwithstanding any other provision of this section—(1) no person shall be ineligible to receive payments or compensation under an acreage reserve contract for 1958 by reason of the fact that the corn acreage on the farm exceeds the farm acreage allotment for corn if the county in which such farm is located is included in the commercial corn producing area for the first time in 1958; (2) no person shall be ineligible to receive payments or compensation under an acreage reserve contract for any year subsequent to 1958 or a conservation reserve contract by reason of the fact that the corn acreage on the farm exceeds the farm acreage allotment for corn if such contract was entered into prior to January 1 of the first year for which the county is included in the commercial corn producing area: *Provided*, That the foregoing provisions of this sentence shall apply only to a farm for which an "old farm" corn allotment is established for such first year. For purposes of this provision, a contract which has been terminated by the producer under the program regulations by reason of the fact that the county in which the farm is located was included in the commercial corn-producing area for the first time in 1958, and which is reinstated, shall be deemed to have been entered into as of the original date of execution of such contract.[12] (7 U.S.C. 1802.)

REAPPORTIONMENT PROHIBITED

SEC. 115. No acreage diverted from the production of any commodity subject to acreage allotments as a result of participation in the acreage reserve or conservation reserve programs shall be reapportioned or allotted to any other farm. (7 U.S.C. 1803.)

CERTIFICATE OF CLAIMANT

SEC. 116. Subject to the provisions of section 105(b), payment or compensation authorized by this title may be made upon the certificate of the claimant, in such form, as the Secretary may prescribe, that he has complied with all requirements for such payment and that the statements and information contained in the application for payment are correct and true, to the best of his knowledge and belief. (7 U.S.C. 1804.)

UTILIZATION OF LOCAL AND STATE COMMITTEES

SEC. 117. In administering this title in the continental United States, the Secretary shall utilize the services of local, county, and State committees established under section 8 of the Soil Conservation and Domestic Allotment Act, as amended. (7 U.S.C. 1805.)

[12] The preceding two sentences were added by the Act of April 7, 1958, 72 Stat. 81.

UTILIZATION OF OTHER AGENCIES

SEC. 118. With respect to conservation aspects of any program under this title, the Secretary shall consult with the soil-conservation districts, State foresters, State game and fish agencies, land-grant colleges, and other appropriate agencies of State governments, and with the Fish and Wildlife Service, in the formulation of program provisions at the State and county levels. The technical resources of the Soil Conservation Service, the Forest Service, the land-grant colleges, the State foresters, State game and fish agencies, the Fish and Wildlife Service, and other appropriate technical services shall be utilized, so far as practicable, to assure coordination of conservation activities and a solid technical foundation for the program. (7 U.S.C. 1806.)

UTILIZATION OF LAND USE CAPABILITY DATA

SEC. 119. In administering this title the Secretary shall utilize to the fullest practicable extent land use capability data, including capability surveys as developed by the Soil Conservation Service, and shall carry forward to completion as rapidly as possible the basic land inventory of the Nation. (7 U.S.C. 1807.)

FINANCING

SEC. 120. (a) The Secretary is authorized to utilize the facilities, services, authorities, and funds of the Commodity Credit Corporation in discharging his functions and responsibilities under this title, including payment of costs of administration for the programs authorized under this title: *Provided*, That the Secretary shall, prior to February 1, 1957, or such earlier date as may be practicable, submit to the Congress a full program of all operations under this title which will require the making of expenditures during the fiscal year ending June 30, 1958; and, after June 30, 1957, the Commodity Credit Corporation shall not make any expenditures for carrying out the purposes of this title unless the Corporation has received funds to cover such expenditures from appropriations made to carry out the purposes of this title. There are hereby authorized to be appropriated such sums as may be necessary to carry out the purposes of this title, including such amounts as may be required to make payments to the Corporation for its actual costs incurred or to be incurred under this section. (7 U.S.C. 1808(a).)

(b) All funds available for carrying out the purposes of this title shall be available for transfer to such agencies of the Federal or State governments as the Secretary may request to cooperate or assist in carrying out this title; and for technical assistance in formulating and carrying out the programs authorized by this title. The Secretary may make such payments in advance of determination of performance. (7 U.S.C. 1808(b).)

FINALITY OF DETERMINATIONS

SEC. 121. The facts constituting the basis for any payment or compensation, or the amount thereof, authorized to be made under this

title, when officially determined in conformity with applicable regulations prescribed by the Secretary, shall be final and conclusive and shall not be reviewable by any other officer or agency of the Government. In case any producer who is entitled to any payment or compensation dies, becomes incompetent, or disappears before receiving such payment or compensation, or is succeeded by another who renders or completes the required performance, the payment or compensation shall, without regard to any other provisions of law, be made as the Secretary may determine to be fair and reasonable in all the circumstances and so provide by regulations. (7 U.S.C. 1809.)

PROTECTION OF TENANTS AND SHARECROPPERS

SEC. 122. In the formulation and administration of programs under this title, the Secretary shall provide adequate safeguards to protect the interests of tenants and sharecroppers, including provision for sharing, on a fair and equitable basis, in payments or compensation under this title, and including such provision as may be necessary to prevent them from being forced off the farm. Applications to participate in any such program shall specify the basis on which the landlord, tenants, and sharecroppers are to share in such payments or compensation, and no contract under any such program shall be entered into unless such basis is approved by the county committee and incorporated into the contract. The standards prescribed by the Secretary for the guidance of county committees in determining whether any such basis shall be approved shall include the requirement that consideration be given to the respective contributions which would have been made by the landlord, tenants, and sharecroppers in the production of the crops which would have been produced on the acreage diverted from production under the contract and the basis on which they would have shared in such crops or the proceeds thereof. (7 U.S.C. 1810.)

PENALTY FOR GRAZING OR HARVESTING

SEC. 123. Any producer who knowingly and willfully grazes or harvests any crop from any acreage in violation of a contract entered into under section 103 or 107 shall be subject to a civil penalty equal to 50 per centum of the compensation payable for compliance with such contract for the year in which the violation occurs. Such penalty shall be in addition to any amount required to be forfeited or refunded under the provisions of such contract, and shall be recoverable in a civil suit brought in the name of the United States. (7 U.S.C. 1811.)

REGULATIONS

SEC. 124. The Secretary shall prescribe such regulations as he determines necessary to carry out the provisions of this title. (7 U.S.C. 1812.)

PRODUCTION ON GOVERNMENT LANDS PROHIBITED

SEC. 125. The President shall, with respect to farmlands now or hereafter owned by the Federal Government, restrict insofar as practicable the leasing of such lands for the production of price supported

crops in surplus supply. Nothing contained in this section shall prevent the production of such crops on national wildlife refuges under cooperative permits where such production is necessary to maintain satisfactory wildlife populations, especially of waterfowl for beneficial use. The provisions of this section shall not be applicable with respect to the leasing of such farmlands to the former owners thereof.[13] (7 U.S.C. 1813.)

POOLING OF CONSERVATION RESERVE LAND

SEC. 126. Whenever management of family farms or optimum land use will be aided, the Secretary of Agriculture is authorized to permit farmers to pool their rights to participate jointly in the conservation reserve program on property other than their home farms. (7 U.S.C. 1814.)

COMPENSATION FOR INCORRECT INFORMATION FURNISHED UNDER 1956 PROGRAM

SEC. 127. In any case under the 1956 program in which a producer, in reliance, in good faith, on incorrect or incomplete information furnished to him by an authorized representative of the Secretary, entered into an acreage reserve or conservation reserve contract, or took action with the intention of entering into such a contract, and the producer is not entitled to receive under the provisions of the program the payment which was stipulated in the contract, or which would have been stipulated if a contract had been entered into, the Secretary is hereby authorized, whenever he deems it desirable in order to provide fair and equitable treatment to such a producer, to compensate such producer for any loss suffered by him as a result of action taken for the purpose of participating in the program.[14] (7 U.S.C. 1815.)

EQUITABLE TREATMENT FOR PRODUCERS PARTICIPATING IN THE SOIL BANK PROGRAM ON THE BASIS OF INCORRECT INFORMATION FURNISHED BY THE GOVERNMENT

SEC. 128.[15] Notwithstanding any other provision of law, the Secretary may, to the extent he deems it desirable in order to provide fair and equitable treatment, pay a producer compensation under the acreage reserve or conservation reserve program which he otherwise would not be entitled to receive because the contract, application therefor, action, or conduct of the producer is—

(1) not in conformity with the provisions of the program, or

(2) less favorable to the producer than would have been the case if it had been based on correct information, or

(3) based on an understanding that payment would be forthcoming in an amount in excess of that permitted by the program

if it is established to the satisfaction of the Secretary that the con-

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[13] Last sentence was added by the Act of April 9, 1960, 74 Stat. 42.
[14] Sec. 127 added by the Act of May 16, 1958, 72 Stat. 118.
[15] Sec. 128 added by the Act of September 14, 1959, 73 Stat. 552.

tract, application, action, or conduct of the producer was the result of relying in good faith on the erroneous approval of such contract, application, action, or conduct by, or on the erroneous advice, determination, or computation of, an authorized representative of the Secretary. No contract heretofore or hereafter entered into shall be modified, invalidated, or changed because of the marriage of any two contracting parties. (7 U.S.C. 1816.)

PART IV

PRICE SUPPORT, SALES AND OTHER DISPOSAL

SUBPART A—LEGAL HISTORY AND CHARTER OF COMMODITY CREDIT CORPORATION

LEGAL HISTORY OF COMMODITY CREDIT CORPORATION

The Commodity Credit Corporation was created on October 17, 1933, under the laws of the State of Delaware pursuant to Executive Order No. 6340, dated October 16, 1933, issued by virtue of the authority vested in the President by section 2(a) of the National Industrial Recovery Act of June 16, 1933 (48 Stat. 195). The Act of January 31, 1935 (15 U.S.C. 713), directed that the Corporation should "continue until April 1, 1937, or such earlier date as may be fixed by the President by Executive Order, to be an agency of the United States." The Corporation was continued until June 30, 1948, as an agency of the United States by successive amendments to the Act of January 31, 1935. By section 401 of the President's reorganization plan No. I (5 U.S.C. 133t, note), effective July 1, 1939, the Corporation was made a part of the United States Department of Agriculture, and its operations were placed under the supervision and control of the Secretary of Agriculture.

The Commodity Credit Corporation was originally capitalized for $3,000,000 subscribed by the Secretary of Agriculture and the Governor of the Farm Credit Administration. The funds for such subscription were derived from the appropriation authorized by section 220 of the National Industrial Recovery Act (48 Stat. 210) and made by the Fourth Deficiency Act, fiscal year 1933 (48 Stat. 274). In accordance with the Act of April 10, 1936 (15 U.S.C. 713a), the Corporation's capitalization was increased to $100,000,000, the additional $97,000,000 of the Corporation's stock being acquired by the Reconstruction Finance Corporation. By section 3 of the Act of March 8, 1938 (15 U.S.C. 713a–3), the Secretary of Agriculture, the Governor of the Farm Credit Administration, and the Reconstruction Finance Corporation were directed to transfer the ownership of the stock of the Corporation to the United States. That section also provided that all rights of the United States arising out of the ownership of such stock should be exercised by the President of the United States or by such officers or agencies as he might designate. Executive Order No. 8219, issued August 7, 1939 (4 F.R. 3565), transferred to the Secretary of Agriculture the authority to exercise on behalf of the United States all rights arising out of the ownership of the stock of the Commodity Credit Corporation.

The Delaware charter of the Commodity Credit Corporation authorized the Corporation, among other things, to engage in buying,

selling, lending, and other activities with respect to agricultural commodities, products thereof, and related facilities. These charter powers enabled the Corporation to engage in extensive operations for the purpose of increasing production, stabilizing prices, assuring adequate supplies, and facilitating the efficient distribution of agricultural commodities, foods, feeds, and fibers. Many of the Corporation's operations were carried out in response to specific congressional mandates. In carrying out its operations, the Corporation was also subject to certain specific limitations placed upon it by the Congress.

Section 304(b) of the Government Corporation Control Act (31 U.S.C. 869) required that wholly-owned Government corporations incorporated under State law be reincorporated by Act of the Congress in order to continue as agencies or instrumentalities of the United States after June 30, 1948. Accordingly, the Commodity Credit Corporation was incorporated as a Federal corporation by the Commodity Credit Corporation Charter Act, effective as of midnight, June 30, 1948. Pursuant to the Charter Act and by appropriate action of the boards of directors of the Delaware and the Federal corporations, all the assets, funds, property, and records of the Delaware corporation were transferred to the Federal corporation, and the rights and duties and liabilities of the Delaware corporation were assumed by the Federal corporation. The Charter Act also directed the dissolution of the Delaware corporation, and the Commodity Credit Corporation, a Delaware corporation, was dissolved under the laws of the State of Delaware, effective as of 9 a.m., September 15, 1948.

The Charter Act incorporated the Federal corporation for substantially the same purposes which the Delaware corporation had served, and made applicable to the Federal corporation the statutes which had been applicable to the Delaware corporation.

COMMODITY CREDIT CORPORATION CHARTER ACT[1]

AN ACT

To Provide a Federal Charter for the Commodity Credit Corporation

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Commodity Credit Corporation Charter Act." (15 U.S.C. 714 note.)

SEC. 2. CREATION AND PURPOSES.—For the purpose of stabilizing, supporting, and protecting farm income and prices, of assisting in the maintenance of balanced and adequate supplies of agricultural commodities, products thereof, foods, feeds, and fibers (hereinafter collectively referred to as "agricultural commodities"), and of facilitating the orderly distribution of agricultural commodities, there is hereby created a body corporate to be known as Commodity Credit Corporation (hereinafter referred to as the "Corporation"), which shall be an agency and instrumentality of the United States, within the Department of Agriculture, subject to the general[2] supervision and direction of the Secretary of Agriculture (hereinafter referred to as the "Secretary"). (15 U.S.C. 714.)

SEC. 3. OFFICES.—The Corporation may establish offices in such place or places as it may deem necessary or desirable in the conduct of its business. (15 U.S.C. 714a.)

SEC. 4. GENERAL POWERS.—The Corporation—

(a) Shall have succession in its corporate name. (15 U.S.C. 714b (a).)

(b) May adopt, alter, and use a corporate seal, which shall be judicially noticed. (15 U.S.C. 714b(b).)

(c) May sue and be sued, but no attachment, injunction, garnishment or other similar process, mesne or final, shall be issued against the Corporation or its property. The district courts of the United States, including the districts courts of the District of Columbia and of any Terriory or possession, shall have exclusive original jurisdiction, without regard to the amount in controversy,[3] of all suits brought by or against the Corporation: *Provided*, That the Corporation may intervene in any court in any suit, action, or proceeding in which it has an interest. Any suit against the Corporation shall be brought in the District of Columbia, or in the district wherein the plaintiff resides or is engaged in business. No suit by or against the Corporation shall be allowed unless (1) it shall have been brought within six years after the right accrued on which suit is brought, or (2) in the event that the person bringing such suit shall have been under legal disability or beyond the seas at the time the right accrued, the suit shall have

[1] Approved June 29, 1948, 62 Stat. 1070.
[2] Prior to amendment by the Act of June 7, 1949, 63 Stat. 154, the balance of the sentence read, "direction and control of its Board of Directors."
[3] This phrase was added by the Act of June 7, 1949, 63 Stat. 154.

been brought within three years after the disability shall have ceased or within six years after the right accrued on which suit is brought, whichever period is longer. The defendant in any suit by or against the Corporation may plead, by way of set-off or counterclaim, any cause of action, whether arising out of the same transaction or not, which would otherwise be barred by such limitation if the claim upon which the defendant's cause of action is based had not been barred prior to the date that the plaintiff's cause of action arose: *Provided*, That the defendant shall not be awarded a judgment on any such set-off or counterclaim for any amount in excess of the amount of the plaintiff's claim established in the suit.[4] All suits against the Corporation shall be tried by the court without a jury. Notwithstanding any other provision of this Act, the Federal Tort Claims Act (Public Law 601, Seventy-ninth Congress) shall be applicable to the Corporation. Any suit by or against the United States as the real party in interest based upon any claim by or against the Corporation shall be subject to the provisions of this subsection (c) to the same extent as though such suit were by or against the Corporation,[5] except that (1) any such suit against the United States based upon any claim of the type enumerated in title 28, section 1491, of the United States Code, may be brought in the United States Court of Claims, and (2) no such suit against the United States may be brought in a district court unless such suit might, without regard to the provisions of this Act, be brought in such court. (15 U.S.C. 714b(c).)

(d) May adopt, amend, and repeal bylaws, rules, and regulations governing the manner in which its business may be conducted and the powers vested in it may be exercised. (15 U.S.C. 714b(d).)

(e) Shall have all the rights, privileges, and immunities of the United States with respect to the right to priority of payment with respect to debts due from insolvent, deceased, or bankrupt debtors. The Corporation may assert such rights, privileges, and immunities in any suit, action, or proceeding. (15 U.S.C. 714b(e).)

(f) Shall be entitled to the use of the United States mails in the same manner and upon the same conditions as the executive departments of the Federal Government. (15 U.S.C. 714b(f).)

(g) May enter into and carry out such contracts or agreements as are necessary in the conduct of its business. State and local regulatory laws or rules shall not be applicable with respect to contracts or agreements of the Corporation or the parties thereto to the extent that such contracts or agreements provide that such laws or rules shall not be applicable, or to the extent that such laws or rules are inconsistent with such contracts or agreements. (15 U.S.C. 714b (g).)

(h) May contract for the use, in accordance with the usual customs of trade and commerce, of plants and facilities for the physical handling, storage, processing, servicing, and transportation of the agricultural commodities subject to its control.[6] The Corporation shall

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[4] This and the preceding sentence were substituted by the Act of June 7, 1949, 63 Stat. 154, for the sentence reading "No suit by or against the Corporation shall be allowed unless it shall have been brought within four years after the right accrued on which suit is brought."

[5] The balance of the sentence was added by the Act of June 7, 1949, 63 Stat. 154.

[6] The balance of subsection (h) was substituted for previous language by the Act of June 7, 1949, 63 Stat. 154.

have power to acquire personal property necessary to the conduct of its business but shall not have power to acquire real property or any interest therein except that it may (a) rent or lease office space necessary for the conduct of its business and (b) acquire real property or any interest therein for the purpose of providing storage adequate to carry out effectively and efficiently any of the Corporation's programs, or of securing or discharging obligations owing to the Corporation, or of otherwise protecting the financial interest of the Corporation: *Provided*, That the authority contained in this subsection (h) shall not be utilized by the Corporation for the purpose of acquiring real property, or any interest therein, in order to provide storage facilities for any commodity unless the Corporation determines that existing privately owned storage facilities for such commodity in the area concerned are not adequate: *Provided further*, That no refrigerated cold storage facilities shall be constructed or purchased except with funds specially provided by Congress for that purpose: *And provided further*, That nothing contained in this subsection (h) shall limit the duty of the Corporation, to the maximum extent practicable consistent with the fulfillment of the Corportation's purposes and the effective and efficient conduct of its business, to utilize the usual and customary channels, facilities, and arrangements of trade and commerce in the warehousing of commodities: *And provided further*, That to encourage the storage of grain on farms, where it can be stored at the lowest cost, the Corporation shall make loans to grain growers needing storage facilities when such growers shall apply to the Corporation for financing the construction or purchase of suitable storage, and these loans shall be deducted from the proceeds of price support loans or purchase agreements made between the Corporation and the growers.[7] Notwithstanding any other provision of law, the Commodity Credit Corporation is authorized, upon terms and conditions prescribed or approved by the Secretary of Agriculture, to accept strategic and critical materials produced abroad in exchange for agricultural commodities acquired by the Corporation.[8] Insofar as practicable, in effecting such exchange of goods, normal commercial trade channels shall be utilized and priority shall be given to commodities easily storable and those which serve as prime incentive goods to stimulate production of critical and strategic materials. The determination of the quantities and qualities of such materials which are desirable for stockpiling and the determination of which materials are strategic and critical shall be made in the manner prescribed by section 2 of the Strategic and Critical Materials Stock Piling Act (60 Stat. 596). Strategic and critical materials acquired by Commodity Credit Corporation in exchange for agricultural commodities shall, to the extent

[7] See sec. 417 of the Agricultural Act of 1949 relating to loans by the Banks for Cooperatives to cooperative associations to finance construction of structures for storage of agricultural commodities if Commodity Credit Corporation has agreed to lease or guarantee utilization of 75 percent of the storage space.

[8] See also sec. 303 of the Agricultural Trade Development and Assistance Act of 1954, sec. 206 of the Agricultural Act of 1956, and sec. 416 of the Agricultural Act of 1949 relating to barters and exchanges of agricultural commodities owned by Commodity Credit Corporation for strategic and other materials. Strategic materials may also be acquired under sec. 104(b) (by purchase, using foreign currencies accruing under Title I) and sec. 104(g) (in payment of loans to promote multilateral trade and economic development) of the Agricultural Trade Development and Assistance Act of 1954.

approved by the Munitions Board of the Department of Defense,[9] be transferred to the stock pile provided for by the Strategic and Critical Materials Stock Piling Act; and when transferred to the stock pile the Commodity Credit Corporation shall be reimbursed for the strategic and critical materials so transferred to the stock pile from the funds made available for the purpose of the Strategic and Critical Materials Stock Piling Act, in an amount equal to the fair market value, as determined by the Secretary of the Treasury,[10] of the material transferred to the stock pile. Nothing contained herein shall limit the authority of the Commodity Credit Corporation to acquire, hold, or dispose of such quantity of strategic and critical materials as it deems advisable in carrying out its functions and protecting its assets. (15 U.S.C. 714b(h).)

(i) May borrow money subject to any provision of law applicable to the Corporation: *Provided*, That the total of all money borrowed by the Corporation, other than trust deposits and advances received on sales, shall not at any time exceed in the aggregate $14,500,000,000.[11] The Corporation shall at all times reserve a sufficient amount of its authorized borrowing power which, together with other funds available to the Corporation, will enable it to purchase, in accordance with its contracts with lending agencies, notes, or other obligations evidencing loans made by such agencies under the Corporation's programs. (15 U.S.C. 714b(i).)

(j) Shall determine the character of and the necessity for its obligations and expenditures and the manner in which they shall be incurred, allowed, and paid. (15 U.S.C. 714b(j).)

(k) Shall have authority to make final and conclusive settlement and adjustment of any claims by or against the Corporation or the accounts of its fiscal officers. (15 U.S.C. 714b(k).)

(l) May make such loans and advances of its funds as are necessary in the conduct of its business. (15 U.S.C. 714b(l).)

(m) Shall have such powers as may be necessary or appropriate for the exercise of the powers specifically vested in the Corporation, and all such incidental powers as are customary in corporations generally; but any research financed by the Corporation shall relate to the conservation or disposal of commodities owned or controlled by the Corporation and shall be conducted in colaboration with research agencies of the Department of Agriculture. (15 U.S.C. 714b(m).)

SEC. 5. SPECIFIC POWERS.—In the fulfillment of its purposes and in carrying out its annual budget programs submitted to and approved by the Congress pursuant to the Government Corporation Control Act (31 U.S.C. 841–871), the Corporation is authorized to use its general powers only to—

(a) Support the prices of agricultural commodities through loans, purchases, payments, and other operations.

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[9] "Department of Defense" substituted for "National Military Establishment" by the Act of August 10, 1949, 63 Stat. 578, 591.

[10] This function was transferred to the Administrator of General Services, by sec. 102 of the Act of June 30, 1949, 63 Stat. 380, 5 U.S.C. 630a.

[11] Borrowing power increased from $4,750,000,000 to $6,750,000,000 by the Act of June 28, 1950, 64 Stat. 261; to $8,500,000,000 by the Act of March 20, 1954, 68 Stat. 30; to $10,000,000,000 by the Act of August 31, 1954, 68 Stat. 1047; to $12,000,000,000 by the Act of August 11, 1955, 69 Stat. 634; and to $14,500,000,000 by the Act of August 1, 1956, 70 Stat. 783.

(b) Make available materials and facilities required in connection with the production and marketing of agricultural commodities.

(c) Procure agricultural commodities for sale to other Government agencies, foreign governments, and domestic, foreign, or international relief or rehabilitation agencies, and to meet domestic requirements.

(d) Remove and dispose of or aid in the removal or disposition of surplus agricultural commodities.

(e) Increase the domestic consumption of agricultural commodities by expanding or aiding in the expansion of domestic markets or by developing or aiding in the development of new and additional markets, marketing facilities, and uses for such commodities.

(f) Export or cause to be exported, or aid in the development of foreign markets for, agricultural commodities.

(g) Carry out such other operations as the Congress may specifically authorize or provide for.

In the Corporation's purchasing and selling operations with respect to agricultural commodities (except sales to other Government agencies), and in the warehousing, transporting, processing, or handling of agricultural commodities, the Corporation shall, to the maximum extent practicable consistent with the fulfillment of the Corporation's purposes and the effective and efficient conduct of its business, utilize the usual and customary channels, facilities, and arrangements of trade and commerce.[12] (15 U.S.C. 714c.)

SEC. 6. EXISTING STATUTES APPLICABLE TO THE CORPORATION.—The Federal statutes applicable to Commodity Credit Corporation, a Delaware corporation, shall be applicable to the Corporation. Commodity Credit Corporation, a Delaware corporation, shall cease to be an agency of the United States as provided in section 7(a) of the Act of January 31, 1935, as amended (15 U.S.C., 1940 edition, Supp. V, 713(a)). (15 U.S.C. 714d.)

SEC. 7. CAPITAL STOCK.—The Corporation shall have a capital stock of $100,000,000 which shall be subscribed by the United States. Such subscription shall be deemed to be fully paid by the transfer of assets to the Corporation pursuant to section 16 of this Act. The Corporation shall pay interest to the United States Treasury on the amount of its capital stock, and on the amount of the obligations of the Corporation purchased by the Secretary of the Treasury pursuant to the Act of March 8, 1938 (U.S.C., title 15, sec. 713a–4), as amended, at such rates as may be determined by the Secretary of the Treasury to be appropriate in view of the terms for which, such amounts are made available to the Corporation. (15 U.S.C. 714e.)

SEC. 8. FUNDS.—The Corporation is authorized to use in the conduct of its business all its funds and other assets, including capital and net earnings therefrom, and all funds and other assets which have been or may hereafter be transferred or allocated to, borrowed by, or otherwise acquired by it. (15 U.S.C. 714f.)

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[12] For similar policy statement with regard to Commodity Credit Corporation's operations, see p. 327, Food and Agriculture Act of 1962, sec. 402.

SEC. 9. DIRECTORS, ADVISORY BOARD.—(a) The management of the Corporation shall be vested in a board of directors (hereinafter referred to as the "Board"), subject to the general supervision and direction of the Secretary. The Secretary shall be an ex officio director and shall serve as Chairman of the Board. The Board shall consist of six members (in addition to the Secretary), who shall be appointed by the President by and with the advice and consent of the Senate. In addition to their duties as members of the Board, such appointed members shall perform such other duties as may be prescribed by the Secretary. Each appointed member of the Board shall receive compensation at such rate not in excess of the maximum then payable under the [CLASSIFICATION ACT OF 1949],[13] as may be fixed by the Secretary, except that any such member who holds another office or position under the Federal Government the compensation for which exceeds such rate may elect to receive compensation at the rate provided for such other office or position in lieu of the compensation provided by this section. A majority of the directors shall constitute a quorum of the Board and action shall be taken only by a majority vote of those present. (15 U.S.C. 714g(a).)

(b) In addition to the Board of Directors there shall be an advisory board reflecting broad agricultural and business experience in its membership and consisting of five members who shall be appointed by the President, and who shall serve at the pleasure of the President. Not more than three of such members shall belong to the same political party. The advisory board shall meet at the call of the Secretary, who shall require it to meet not less often than once each ninety days; shall survey the general policies of the Corporation, including its policies in connection with the purchase, storage, and sale of commodities, and the operation of lending and price-support programs; and shall advise the Secretary with respect thereto. Members of the advisory board shall receive for their services as members compensation of not to exceed $50 per diem when actually engaged in the performance of their duties as such, together with their necessary traveling expenses while going to and coming from meetings.[14] (15 U.S.C. 714g(b).)

SEC. 10. PERSONNEL OF CORPORATION.—The Secretary shall appoint such officers and employees as may be necessary for the conduct of the business of the Corporation, define their authority and duties, delegate to them such of the powers vested in the Corporation as he may determine, require that such of them as he may designate be bonded and fix the penalties therefor. The Corporation may pay the premium of any bond or bonds. With the exception of experts, appointments shall be made pursuant to the civil service laws and the [Classification Act of 1949].[15] (15 U.S.C. 714h)

SEC. 11. COOPERATION WITH OTHER GOVERNMENT AGENCIES.—The Corporation may, with the consent of the agency concerned, accept and utilize, on a compensated or uncompensated basis, the

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[13] As originally enacted, secs. 9 and 10 referred to the Classification Act of 1923, as amended, which was repealed and superseded by the Classification Act of 1949 (approved October 28, 1949, 63 Stat. 954; 5 U.S.C. 1071).

[14] The provisions of this section were substituted for the previous provisions by the Act of June 7, 1949, 63 Stat. 154, 155.

[15] The provisions of this section were substituted for the previous provisions by the Act of June 7, 1949, 63 Stat. 154, 156.

officers, employees, services, facilities, and information of any agency of the Federal Government, including any bureau, office, administration, or other agency of the Department of Agriculture, and of any State, the District of Columbia, any Territory or possession, or any political subdivision thereof. The Corporation may allot to any bureau, office, administration, or other agency of the Department of Agriculture or transfer to such other agencies as it may request to assist it in the conduct of its business any of the funds available to it for administrative expenses. The personnel and facilities of the Corporation may, with the consent of the Corporation, be utilized on a reimbursable basis by any agency of the Federal Government, including any bureau, office, administration, or other agency of the Department of Agriculture, in the performance of any part or all of the functions of such agency. (15 U.S.C. 714i.)

SEC. 12. UTILIZATION OF ASSOCIATIONS AND TRADE FACILITIES.—The Corporation may, in the conduct of its business, utilize on a contract or fee basis, committees or associations of producers, producer-owned and producer-controlled cooperative associations, and trade facilities. (15 U.S.C. 714j.)

SEC. 13. RECORDS; ANNUAL REPORT.—The Corporation shall at all times maintain complete and accurate books of account and shall file annually with the Secretary of Agriculture a complete report as to the business of the Corporation, a copy of which shall be forwarded by the Secretary of Agriculture to the President for transmission to the Congress. (15 U.S.C. 714k.)

SEC. 14. INTEREST OF MEMBERS OF THE CONGRESS.—The provisions of section 1 of the Act of February 27, 1877, as amended (41 U.S.C., 1940 edition, 22), shall apply to all contracts or agreements of the Corporation, except contracts or agreements of a kind which the Corporation may enter into with farmers participating in a program of the Corporation. (15 U.S.C. 714*l*.)

SEC. 15. CRIMES AND OFFENSES.—

FALSE STATEMENTS; OVERVALUATION OF SECURITIES

(a) Whoever makes any statement knowing it to be false, or whoever willfully overvalues any security, for the purpose of influencing in any way the action of the Corporation, or for the purpose of obtaining for himself or another, money, property, or anything of value, under this Act, or under any other Act applicable to the Corporation, shall, upon conviction thereof, be punished by a fine of not more than $10,000 or by imprisonment by not more than five years, or both. (15 U.S.C. 714 m(a).)

EMBEZZLEMENT, AND SO FORTH; FALSE ENTRIES; FRAUDULENT ISSUE OF OBLIGATIONS OF CORPORATION

(b) Whoever, being connected in any capacity with the Corporation or any of its programs, (i) embezzles, abstracts, purloins, or willfully misapplies any money, funds, securities, or other things of value, whether belonging to the Corporation or pledged, or otherwise entrusted to it; or (ii) with intent to defraud the Corporation,

or any other body, politic or corporate, or any individual, or to deceive any officer, auditor, or examiner of the Corporation, makes any false entry in any book, report, or statement of, or to, the Corporation, or draws any order, or issues, puts forth or assigns any note or other oblization or draft, mortgage, judgment, or decree thereof; or (iii) with intent to defraud the Corporation, participates or shares in, or receives directly or indirectly any money, profit, property, or benefits through any transaction, loan, commission, contract, or any other act of the Corporation, shall, upon conviction thereof, be punished by a fine of not more than $10,000 or by imprisonment for not more than five years, or both. (15 U.S.C. 714m(b).)

LARCENY; CONVERSION OF PROPERTY

(c) Whoever shall willfully steal, conceal, remove, dispose of, or convert to his own use or to that of another any property owned or held by, or mortgaged or pledged to, the Corporation, or any property mortgaged or pledged as security for any promissory note, or other evidence of indebtedness, which the Corporation has guaranteed or is obligated to purchase upon tender, shall, upon conviction thereof, if such property be of an amount or value in excess of $500, be punished by a fine of not more than $10,000 or by imprisonment for not more than five years, or both, and, if such property be of an amount or value of $500 or less, be punished by a fine of not more than $1,000 or by imprisonment for not more than one year, or both.[16] (15 U.S.C. 714m(c).)

CONSPIRACY TO COMMIT OFFENSE

(d) Whoever conspires with another to accomplish any of the acts made unlawful by the preceding provisions of this section shall, upon conviction thereof, be subject to the same fine or imprisonment, or both, as is applicable in the case of conviction for doing such unlawful acts. (15 U.S.C. 714m(d).)

GENERAL STATUTES APPLICABLE

(e) All the general penal statutes relating to crimes and offenses against the United States shall apply with respect to the Corporation, its property, money, contracts and agreements, employees, and operations: *Provided*, That such general penal statutes shall not apply to the extent that they relate to crimes and offenses punishable under subsections (a), (b), (c), and (d) of this section: *Provided further*, That sections 114 and 115 of the Act of March 4, 1909, as amended (18 U.S.C., 1940 edition, 204, 205), shall not apply to contracts or agreements of a kind which the Corporation may enter into with farmers participating in a program of the Corporation. (15 U.S.C. 714m(e).)

USE OF WORDS "COMMODITY CREDIT CORPORATION"

(f) No individual, association, partnership, or corporation shall use the words "Commodity Credit Corporation" or any combination

[16] Substituted for original provisions of this subsection by the Act of August 1, 1956, Stat. 783.

of the same, as the name or a part thereof under which he or it shall do or purport to do business. Every individual, partnership, association, or corporation violating this prohibition shall be guilty of a misdemeanor and shall be punished by a fine of not more than $1,000 or by imprisonment for not more than one year, or both.[17] (15 U.S.C. 714m(f).)

SEC. 16. TRANSFER OF ASSETS OF COMMODITY CREDIT CORPORATION, A DELAWARE CORPORATION.—The assets, funds, property, and records of Commodity Credit Corporation, a Delaware corporation, are hereby transferred to the Corporation. The rights, privileges, and powers, and the duties and liabilities of Commodity Credit Corporation, a Delaware corporation, in respect to any contract, agreement, loan, account, or other obligation shall become the rights, privileges, and powers, and the duties and liabilities, respectively, of the Corporation. The enforceable claims of or against Commodity Credit Corporation, a Delaware corporation, shall become the claims of or against, and may be enforced by or against, the Corporation: *Provided*, That nothing in this Act shall limit or extend any period of limitation otherwise applicable to such claims against the Corporation. (15 U.S.C. 714n.)

SEC. 17. DISSOLUTION OF DELAWARE CORPORATION.—The Secretary of Agriculture, representing the United States as the sole owner of the capital stock of Commodity Credit Corporation, a Delaware corporation, is hereby authorized and directed to institute or cause to be instituted such proceedings as are required for the dissolution of said Corporation under the laws of the State of Delaware.[18] The costs of such dissolution of said Corporation shall be borne by the Corporation. (15 U.S.C. 714o.)

SEC. 18. EFFECTIVE DATE.—This Act shall take effect as of midnight June 30, 1948. (15 U.S.C. 714 note.)

SEC. 19. RELEASE OF INNOCENT PURCHASERS OF CONVERTED GOODS.—A buyer in the ordinary course of business of fungible goods heretofore or hereafter sold and physically delivered by a warehouseman or other dealer who was regularly engaged in the business of buying and selling such goods shall take or be deemed to have taken such goods free of any claim, existing or hereafter arising, by Commodity Credit Corporation, based on the want of authority in the seller to sell such goods, provided the buyer purchased such goods for value in good faith and did not know or have reason to know of any defect in the seller's authority to sell such goods. To be entitled to relief under this section a buyer must assert as an affirmative defense and establish by a preponderance of the evidence the facts necessary to entitle him to such relief.[19] (15 U.S.C. 714p.)

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[17] Subsec. (f) added by the Act of June 7, 1949, 63 Stat. 154, 157.
[18] The Delaware Corporation was dissolved under the laws of the State of Delaware, effective 9 a.m., September 15, 1948.
[19] Sec. 19 added by the Act of May 23, 1955, 69 Stat. 65.

SUBPART B—PRICE SUPPORT

EXPLANATORY NOTE

Price support directly to producers was first made available in 1933 by loans to cotton and corn producers by the Commodity Credit Corporation. In the Agricultural Adjustment Act of 1938 (Section 302), the Congress enacted the first comprehensive legislation dealing with price support. Additional legislation thereafter included:

The Act of April 3, 1941 (55 Stat. 90; 7 U.S.C. 1359) (providing for loans on peanuts).

The Act of May 26, 1941, as amended (55 Stat. 203, 55 Stat. 860; 7 U.S.C. 1330, 1340) (providing for loans on basic commodities through the 1946 crop).

Section 4 of the Act of July 1, 1941, as amended (55 Stat. 498, 56 Stat. 768; 15 U.S.C. 713a–8) (the so-called "Steagall amendment", which provided that if the Secretary of Agriculture issued an announcement requesting the expansion of production of a non-basic agricultural commodity, he should provide price support on such commodity for two years after World War II).

Section 8 of the Stabilization Act of 1942, as amended (56 Stat. 767, 58 Stat. 643, 58 Stat. 784; 50 U.S.C. App. 968) (providing for loans on basic commodities for two years after World War II).

The Act of July 28, 1945 (59 Stat. 506; 7 U.S.C. 1312 note) (providing for loans on tobacco).

The Act of August 5, 1947, as amended (61 Stat. 769, 62 Stat. 1248; 15 U.S.C. 713a–8 note) (providing for price support on wool).

Much of this legislation expired with the termination of the wartime emergency and was succeeded by the Agricultural Act of 1948 (62 Stat. 1247). The Agricultural Act of 1949 (7 U.S.C. 1421) superseded or repealed prior legislation, effective for the 1950 and subsequent crop years. The Agricultural Act of 1954, the Agricultural Act of 1956, and the Agricultural Act of 1958 (72 Stat. 988) made significant changes in the 1949 Act which have been incorporated therein in this compilation.

The Agricultural Act of 1961 and the Food and Agriculture Act of 1962 made significant changes with respect to wheat and feed grains.

Public Law 88–297, approved April 11, 1964, made important changes with respect to cotton and wheat, and Public Law 88–26, approved May 20, 1963, made certain changes with respect to feed grains.

The Commodity Credit Corporation is the chief instrumentality in making price support available to producers. Export and surplus removal programs operated under Section 32 of Public Law 320, 74th Congress, are also at times utilized as a means of price support.

AGRICULTURAL ACT OF 1949[1]

AN ACT

To stabilize prices of agricultural commodities.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Agricultural Act of 1949." (7 U.S.C. 1421 note.)

TITLE I—BASIC AGRICULTURAL COMMODITIES

SEC. 101. The Secretary of Agriculture (hereinafter called the "Secretary") is authorized and directed to make available through loans, purchases, or other operations, price support to cooperators for any crop of any basic agricultural commodity, if producers have not disapproved marketing quotas for such crop, at a level not in excess of 90 per centum of the parity price of the commodity nor less than the level provided in subsections (a), (b), and (c) as follows:

(a) For tobacco (except as otherwise provided herein), corn, and wheat,[2] if the supply percentage as of the beginning of the marketing year is:

	The level of support shall be not less than the following percentage of the parity price:
Not more than 102	90
More than 102 but not more than 104	89
More than 104 but not more than 106	88
More than 106 but not more than 108	87
More than 108 but not more than 110	86
More than 110 but not more than 112	85
More than 112 but not more than 114	84
More than 114 but not more than 116	83
More than 116 but not more than 118	82
More than 118 but not more than 120	81
More than 120 but not more than 122	80
More than 122 but not more than 124	79
More than 124 but not more than 126	78
More than 126 but not more than 128	77
More than 128 but not more than 130	76
More than 130	75

For rice of the 1959 and 1960 crops, the level of support shall be not less than 75 per centum of the parity price. For rice of the 1961 crop the level of support shall be not less than 70 per centum of the parity price. For the 1962 and subsequent crops of rice the level of support shall be not less than 65 per centum of the parity price.[3] (7 U.S.C. 1441(a).)

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[1] Approved October 31, 1949, 63 Stat. 1051.

[2] This subsection was amended by sec. 302 of the Agricultural Act of 1958, 72 Stat. 994, effective beginning with the 1959 crop, by striking out "wheat, and rice" and inserting "and wheat". For wheat of the 1964 crop and subsequent years see sec. 107 of this Act on p. 154. For corn of the 1959 and subsequent crop years, see sec. 104(a) on p. 151.

[3] This paragraph was added by sec. 302 of the Agricultural Act of 1958, 72 Stat. 994, effective beginning with the 1959 crop.

(b) For cotton and peanuts, if the supply percentage as of the beginning of the marketing year is:

	The level of support shall be not less than the following percentage of the parity price:
Not more than 108	90
More than 108 but not more than 110	89
More than 110 but not more than 112	88
More than 112 but not more than 114	87
More than 114 but not more than 116	86
More than 116 but not more than 118	85
More than 118 but not more than 120	84
More than 120 but not more than 122	83
More than 122 but not more than 124	82
More than 124 but not more than 125	81
More than 125 but not more than 126	80
More than 126 but not more than 127	79
More than 127 but not more than 128	78
More than 128 but not more than 129	77
More than 129 but not more than 130	76
More than 130	75

(7 U.S.C. 1441(b).)

(c) For tobacco, if marketing quotas are in effect, the level of support shall be 90 per centum of the parity price.[4] (7 U.S.C. 1441(c).)

(d) Notwithstanding the foregoing provisions of this section—

(1) if producers have not disapproved marketing quotas for such crop, the level of support to cooperators shall be 90 per centum of the parity price for the 1950 crop of any basic agricultural commodity for which marketing quotas or acreage allotments are in effect;

(2) if producers have not disapproved marketing quotas for such crop, the level of support to cooperators shall be not less than 80 per centum of the parity price for the 1951 crop of any basic agricultural commodity for which marketing quotas or acreage allotments are in effect;

(3) the level of price support to cooperators for any crop of a basic agricultural commodity, except tobacco, for which marketing quotas have been disapproved by producers shall be 50 per centum of the parity price of such commodity; and no price support shall be made available for any crop of tobacco for which marketing quotas have been disapproved by producers;

(4) [5] * * *

(5) price support may be made available to noncooperators at such levels, not in excess of the level of price support to cooperators, as the Secretary determines will facilitate the effective operation of the program.

(6) [6] Except as provided in subsection (c) and section 402, the level of support to cooperators shall be not more than 90 per

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[4] See sec. 106 of this title.

[5] Subsec. (4) was repealed, effective with the 1959 crop, by sec. 201 of the Agricultural Act of 1958, 72 Stat. 993.

[6] Prior to amendment by subsec. 201(a) of the Agricultural Act of 1954, 68 Stat. 899, par. (6) (added by the Act of July 17, 1952, 66 Stat. 758, 759) read: "The level of support of cooperators shall be 90 per centum of the parity price for the 1953 and 1954 crops of any basic agricultural commodity with respect to which producers have not disapproved marketing quotas."

centum and not less than 82½ per centum of the parity price for the 1955 crop of any basic agricultural commodity with respect to which producers have not disapproved marketing quotas; within such limits, the minimum level of support shall be fixed as provided in subsections (a) and (b) of this section.

(7) [7] Where a State is designated under section 335(e) of the Agricultural Adjustment Act of 1938, as amended, as outside the commercial wheat-producing area for any crop of wheat, the level of price support for wheat to cooperators in such State for such crop of wheat shall be 75 per centum of the level of price support to cooperators in the commercial wheat-producing area. (7 U.S.C. 1441(d).)

(e) [8] * * *

(f) The provisions of this Act relating to price support for cotton shall apply severally to (1) American upland cotton and (2) extra long staple cotton described in subsection (a) and ginned as required by subsection (e) of section 347 of the Agricultural Adjustment Act of 1938, as amended, except that, notwithstanding any of the foregoing provisions of section 101 of this Act, the level of support to cooperators for the 1957 and each subsequent crop of extra long staple cotton, if producers have not disapproved marketing quotas therefor, shall not exceed the same per centum of the parity price as for the 1956 crop and shall be determined after consideration of the factors specified in section 401(b) and the price levels for similar qualities of cotton produced outside the United States: *Provided*, That such level of price support shall be not less than 60 per centum of the parity price. Disapproval by producers of the quota proclaimed under such section 347 shall place into effect the provisions of section 101(d)(3) of this Act with respect to the extra long staple cotton described in subsection (a) of such section 347. Nothing contained herein shall affect the authority of the Secretary under section 402 to make support available for extra long staple cotton in accordance with such section 402.[9] (7 U.S.C. 1441(f).)

SEC. 102. [This section was added by sec. 101 of the Agricultural Act of 1958, 72 Stat. 989, but was applicable only to the 1959 and 1960 crops of cotton. See p. 131 of Agriculture Handbook No. 192.]

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[7] Par. (7) added by subsec. 201(b) of the Agricultural Act of 1954, 68 Stat. 899.

[8] Sec. 101(e) (7 U.S.C. 1441(e)) was repealed by the Act of February 20, 1960, 74 Stat. 7. Sec. 101(e) had continued in effect sec. 2 of the Act of July 28, 1945, as amended, providing as follows: "Sec. 2. Notwithstanding any other provision of law, the Commodity Credit Corporation is authorized and directed, beginning with the 1945 crop, to make available upon any crop of fire-cured, dark air-cured and Virginia sun-cured tobacco, if producers have not disapproved marketing quotas for such tobacco for the marketing year beginning with the calendar year in which such crop is harvested, loans or other price support at, in the case of fire-cured tobacco, 75 per centum of the loan rate for burley tobacco for the corresponding crop and, in the case of dark air-cured and Virginia sun-cured tobacco, at 66⅔ per centum of such burley tobacco loan rate: *Provided*, That, beginning with the 1958 crop, the levels of support for such kinds of tobacco shall not exceed the higher of (a) the level applicable to the 1957 crop or (b) 90 per centum of the parity price." (59 Stat. 506; 7 U.S.C. 1312 note.)

Sec. 2 of the Act of July 28, 1945, as amended, was also repealed by the Act of February 20, 1960. However, sec. 106 was added to this title by the Act of February 20, 1960 and provides for tobacco support levels on any kind of tobacco for 1960 and subsequent years.

[9] Subsec. (f) added by the Act of July 17, 1952, 66 Stat. 758, 759. The first sentence has been amended by sec. 202 of the Agricultural Act of 1954, the Act of April 25, 1957, 71 Stat. 27, and the Act of July 2, 1958, 72 Stat. 296.

PRICE SUPPORT FOR 1961 AND SUBSEQUENT YEARS (COTTON)

SEC. 103.[10] (a) Notwithstanding the provisions of section 101 of this Act, price support to cooperators for each crop of upland cotton, beginning with the 1961 crop, for which producers have not disapproved marketing quotas shall be at such level not more than 90 per centum of the parity price therefor nor less than the minimum level prescribed below as the Secretary determines appropriate after consideration of the factors specified in section 401(b) of this Act. For the 1961 crop the minimum level shall be 70 per centum of the parity price therefor, and for each subsequent crop the minimum level shall be 65 per centum of the parity price therefor: *Provided*, That the price support for the 1964 crop shall be a national average support price which reflects 30 cents per pound for Middling one-inch cotton. Price support in the case of noncooperators and in case marketing quotas are disapproved shall be as provided in section 101(d) (3) and (5).

(b) [10] If producers have not disapproved marketing quotas, the Secretary shall provide additional price support on the 1964 and 1965 crops of upland cotton to cooperators on whose farms the acreage planted to upland cotton for harvest does not exceed the farm domestic allotment established under section 350 of the Agricultural Adjustment Act of 1938, as amended. Such additional support shall be at a level up to 15 per centum in excess of the basic level of support established under subsection (a) and shall be provided on the normal yield of the acreage planted for harvest within the farm domestic allotment.

(c) [10] In order to keep upland cotton to the maximum extent practicable in the normal channels of trade, any additional price support under subsection (b) of this section may be carried out through the simultaneous purchase of cotton at the support price therefor under subsection (b) and the sale of such cotton at the support price therefor under subsection (a) or similar operations, including loans under which the cotton would be redeemable by payment of the amount for which the cotton would be redeemable if the loan thereon had been made at the support price for such cotton under subsection (a), or payments-in-kind through the issuance of certificates which the Commodity Credit Corporation shall redeem for cotton under regulations issued by the Secretary. If such additional support is provided through the issuance of payment-in-kind certificates, such certificates shall have a value per pound of cotton equal to the difference between the level of support established under subsection (a) and the level of support established under subsection (b). The corporation may, under regulations prescribed by the Secretary, assist the producers and persons receiving payment-in-kind certificates under this section and section 348 of the Agricultural Adjustment Act of 1938, as amended, in the marketing of such certificates at such time and in such manner as the Secretary determines will best effectuate the purposes of the program authorized by this section and such section 348. In the case of any certificate not presented for redemption with thirty

[10] Sec. 130 added by sec. 102 of the Agricultural Act of 1958, 72 Stat. 980, and amended by Pub. L. 88–297, 78 Stat. 174, approved April 11, 1964, (1) by inserting "(a)" before the first sentence, (2) by adding the proviso after the second sentence, and (3) by adding new subsecs. (b) and (c).

days of the date of its issuance, reasonable costs of storage and other carrying charges as determined by the Secretary for the period beginning thirty days after its issuance and ending with the date of its presentation for redemption shall be deducted from the value of the certificate. (7 U.S.C. 1444.)

REFERENDUM (CORN)

SEC. 104.[11] (a) (Applicable only to the referendum conducted in 1958.)

(b) * * *

SPECIAL COTTON RESEARCH PROGRAM

(c) [12] The Secretary of Agriculture is hereby authorized and directed to conduct a special cotton research program designed to reduce the cost of producing upland cotton in the United States at the earliest practicable date. There are hereby authorized to be appropriated such sums, not to exceed $10,000,000 annually, as may be necessary for the Secretary to carry out this special research program. The Secretary shall report annually to the Committee on Agriculture of the House of Representatives and to the Committee on Agriculture and Forestry of the Senate with respect to the results of such research. (7 U.S.C. 1441 note.)

PRICE SUPPORT FOR 1959 AND SUBSEQUENT YEARS (CORN AND FEED GRAINS)

SEC. 105. (a) [13] Notwithstanding the provisions of section 101 of this Act, beginning with the 1964 crop, price support shall be made available to producers for each crop of corn at such level, not less than 50 per centum or more than 90 per centum of the parity price therefor, as the Secretary determines will not result in increasing Commodity Credit Corporation stocks of corn: *Provided*, That in the case of any crop for which an acreage diversion program is in effect for feed grains, the level of price support for corn of such crop shall be at such level not less than 65 per centum or more than 90 per centum of the parity price therefor as the Secretary determines necessary to achieve the acreage reduction goal established by him for the crop.

(b) [14] Beginning with the 1959 crop, price support shall be made available to producers for each crop of oats, rye, barley, and grain sorghums at such level of the parity price therefor as the Secretary of Agriculture determines is fair and reasonable in relation to the level at which price support is made available for corn, taking into con-

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[11] Subsecs. (a) and (b) (7 U.S.C. 1441 note), which were added by sec. 201 of the Agricultural Act of 1958, 72 Stat. 993, provided for a referendum in 1958 of corn producers to determine if they favored a price support program as provided in sec. 105 in lieu of price support as provided in sec. 101 and acreage allotments. A majority of producers voted for the sec. 105 program, and, beginning with the 1959 crop, price support was made available thereunder and acreage allotments and a commercial corn producing area was not established. This section also repealed subsec. 101(d)(4) of this Act, effective with the 1959 crop.

[12] Subsec. (c) was added by Pub. L. 88–297, 78 Stat. 174, approved April 11, 1964.

[13] The proviso in subsec. (a) was added by Pub. L. 88–26, 77 Stat. 44, approved May 20, 1963. Subsec. (a) was previously amended by sec. 305 of the Food and Agriculture Act of 1962, 76 Stat. 614, approved September 27, 1962.

[14] Subsec. (b) was added by the Agricultural Act of 1958, 72 Stat. 993.

sideration the feeding value of such commodity in relation to corn, and the other factors set forth in section 401(b) hereof.

(c) [15] Notwithstanding any other provision of law—

(1) [This subsection was added by the Act of March 22, 1961, 72 Stat. 994, and is applicable only to the 1961 crops of corn and grain sorghums. See p. 155 of Agriculture Handbook 242.]

(2) [This subsection was added by the Act of March 22, 1961, 72 Stat. 994, and is applicable only to the 1961 crops of corn, grain sorghums and any other feed grains. See p. 155 of Agriculture Handbook 242.]

(3) [This subsection was added by the Agricultural Act of 1961, 75 Stat. 301, and is applicable only to the 1962 crops of corn, grain sorghums, and barley. See p. 156 of Agriculture Handbook 242.]

(4) [This subsection was added by the Agricultural Act of 1961, 75 Stat. 301, and is applicable only to the 1962 crops of corn, grain sorghums and barley. See p. 156 of Agriculture Handbook 242.]

(5) [This subsection was added by the Food and Agriculture Act of 1962, 76 Stat. 612, and is applicable only to the 1963 crops of corn, grain sorghums and barley. See p. 157 of Agriculture Handbook 242.]

(6) [This subsection was added by the Food and Agriculture Act of 1962, 76 Stat. 612, and is applicable only to the 1963 crops of corn, grain sorghums and barley. See p. 157 of Agriculture Handbook 242.]

(d) [16] The provision of this subsection shall be applicable with respect to the 1964 crop and the 1965 crop of feed grains if an acreage diversion program is in effect under section 16(h) of the Soil Conservation and Domestic Allotment Act, as amended. The Secretary shall require as a condition of eligibility for price support on the crop of any feed grain which is included in the acreage diversion program that the producer shall participate in the diversion program to the extent prescribed by the Secretary, and, if no diversion program is in effect for the 1964 crop or the 1965 crop, he may require as a condition of eligibility for price support on such crop of feed grains that the producer shall not exceed his feed grain base: *Provided*, That the Secretary may provide that no producer of malting barley shall be required as a condition of eligibility for price support for barley to participate in the acreage diversion program for feed grains if such producer has previously produced a malting variety of barley, plants barley only of an acceptable malting variety for harvest, does not knowingly devote an acreage on the farm to barley in excess of 110 per centum of the average acreage devoted on the farm to barley in 1959 and 1960, does not knowingly devote an acreage on the farm to corn and grain sorghums in excess of the average acreage devoted on the farm to corn and grain sorghums in 1959 and 1960, and does not devote any acreage devoted to the production of oats and rye in 1959 and 1960 to the production of wheat pursuant to the provisions of

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[15] Subsec. (c) was added by the Act of March 22, 1961, 72 Stat. 994.
[16] Subsec. (d) added by Pub. L. 88–26, 77 Stat. 44, approved May 20, 1963.

section 328 of the Food and Agriculture Act of 1962. Such portion of the support price for any feed grain included in the acreage diversion program as the Secretary determines desirable to assure that the benefits of the price support and diversion programs inure primarily to those producers who cooperate in reducing their acreages of feed grains shall be made available to producers through payments in kind. Such payments in kind shall be made on the number of bushels of such feed grain determined by multiplying the actual acreage of such feed grain planted on the farm for harvest by the adjusted average yield per acre. The base period used in determining such adjusted average yield shall be the same as that used for purposes of the acreage diversion program formulated under section 16(h) of the Soil Conservation and Domestic Allotment Act, as amended. The Secretary may make not to exceed 50 per centum of any payments hereunder to producers in advance of determination of performance. Such payments in kind shall be made through the issuance of negotiable certificates which the Commodity Credit Corporation shall redeem for feed grains (such feed grains to be valued by the Secretary at not less than the current support price minus that part of the current support price made available through payments in kind, plus reasonable carrying charges) and, notwithstanding any other provision of law, the Commodity Credit Corporation shall, in accordance with regulations prescribed by the Secretary, assist the producer in the marketing of such certificates. In the case of any certificate not presented for redemption within thirty days of the date of its issuance, reasonable costs of storage and other carrying charges, as determined by the Secretary, for the period beginning thirty days after its issuance and ending with the date of its presentation for redemption shall be deducted from the value of the certificate. The Secretary shall provide for the sharing of such certificates among the producers on the farm on the basis of their respective shares in the crop produced on the farm with respect to which such certificates are issued, or the proceeds therefrom. If the operator of the farm elects to participate in the acreage diversion program, price support for feed grains included in the program shall be made available to the producers on such farm only if such producers divert from the production of such feed grains in accordance with the provisions of such program an acreage on the farm equal to the number of acres which such operator agrees to divert, and the agreement shall so provide. (7 U.S.C. 1441 note.)

PRICE SUPPORT FOR 1960 AND SUBSEQUENT YEARS (TOBACCO)

SEC. 106.[17] Notwithstanding any of the provisions of section 101 of this Act: (a) For the 1960 crop of any kind of tobacco for which marketing quotas are in effect, or for which marketing quotas are not disapproved by producers, the support level in cents per pound shall be the level at which the 1959 crop of such kind of tobacco was supported, or if marketing quotas were disapproved for the 1959 crop of such kind of tobacco, the level at which the 1959 crop of such kind of tobacco would have been supported if marketing quotas had been in

[17] Sec. 106 added by the Act of February 20, 1960, 74 Stat. 6. See footnote 8 of this Act for price support on tobacco prior to 1960.

effect. (b) For the 1961 crop and each subsequent crop of any kind of tobacco for which marketing quotas are in effect, or for which marketing quotas are not disapproved by producers, the support level in cents per pound shall be determined by adjusting the support level for the 1959 crop of such kind of tobacco, or if marketing quotas were disapproved for the 1959 crop of such kind of tobacco, the level at which the 1959 crop of such kind of tobacco would have been supported if marketing quotas had been in effect, by multiplying such support level for the 1959 crop by the ratio of (i) the average of the index of prices paid by farmers, including wage rates, interest, and taxes, as defined in section 301(a)(1)(C) of the Agricultural Adjustment Act of 1938, as amended, for the three calendar years immediately preceding the calendar year in which the marketing year begins for the crop for which the support level is being determined to (ii) the average index of such prices paid by farmers, including wage rates, interest, and taxes for the calendar year 1959. (7 U.S.C. 1445.)

PRICE SUPPORT FOR 1962 CROP (WHEAT)

[Sec. 123 of the Agricultural Act of 1961, 75 Stat. 296. See p. 158 of Agriculture Handbook 242.]

PRICE SUPPORT FOR 1963 CROP (WHEAT)

[Sec. 306 of the Food and Agriculture Act of 1962, 76 Stat. 614. See p. 159 of Agriculture Handbook 242.]

PRICE SUPPORT FOR 1964 AND SUBSEQUENT YEARS (WHEAT) [18]

SEC. 107.[19] Notwithstanding the provisions of section 101 of this Act, beginning with the 1964 crop—

(1) Price support for wheat accompanied by domestic certificates [20] shall be at such level not less than 65 per centum or more than 90 per centum of the parity price therefor as the Secretary determines appropriate, taking into consideration the factors specified in section 401(b).

(2) Price support for wheat accompanied by export certificates [20] shall be at such level not more than 90 per centum of the parity price therefor as the Secretary determines appropriate, taking into consideration the factors specified in section 401(b).

(3) Price support for wheat not accompanied by marketing certificates shall be at such level, not in excess of 90 per centum of the parity price therefor, as the Secretary determines appropriate, taking into consideration competitive world prices of wheat, the feeding value of wheat in relation to feed grains, and the level at which price support is made available for feed grains.

(4) Price support shall be made available only to cooperators; and, if a commercial wheat-producing area is established for such

[18] For special provisions on durum wheat, see sec. 334(j) of the Agricultural Adjustment Act of 1938, as amended.

[19] Sec. 107 was added by sec. 325 of the Food and Agriculture Act of 1962, 76 Stat. 631, and was amended by Pub. L. 88–297, 78 Stat. 182, approved April 11, 1964.

[20] See sec. 379c of the Agricultural Adjustment Act of 1938, as amended, on p. 105.

crop, price support shall be made available only in the commercial wheat-producing area.

(5) Effective with respect to crops planted for harvest in the calendar year 1966 and any subsequent year, the level of price support for any crop of wheat for which a national marketing quota is not proclaimed or for which marketing quotas have been disapproved by producers shall be as provided in section 101.

(6) A "cooperator" with respect to any crop of wheat produced on a farm shall be a producer who (i) does not knowingly exceed (A) the farm acreage allotment for wheat on the farm or (B) except as the Secretary may by regulation prescribe, the farm acreage allotment for wheat on any other farm on which the producer shares in the production of wheat, and (ii) complies with the land-use requirements of section 339 of the Agricultural Adjustment Act of 1938, as amended, to the extent prescribed by the Secretary. Effective with respect to crops planted for harvest in the calendar year 1966 and any subsequent year, if marketing quotas are not in effect for the crop of wheat, a "cooperator" with respect to any crop of wheat produced on a farm shall be a producer who does not knowingly exceed the farm acreage allotment for wheat. No producer shall be deemed to have exceeded a farm acreage allotment for wheat if the entire amount of the farm marketing excess is delivered to the Secretary or stored in accordance with applicable regulations to avoid or postpone payment of the penalty, but the producer shall not be eligible to receive price support on such marketing excess. No producer shall be deemed to have exceeded the farm acreage allotment for wheat on any other farm, if such farm is exempt from the farm marketing quota for such crop under section 335. No producer shall be deemed to have exceeded a farm acreage allotment for wheat if the production on the acreage in excess of the farm acreage allotment is stored pursuant to the provisions of section 379c(b), but the producer shall not be eligible to receive price support on the wheat so stored. (7 U.S.C. 1445a.)

TITLE II—DESIGNATED NONBASIC AGRICULTURAL COMMODITIES

SEC. 201. The Secretary is authorized and directed to make available (without regard to the provisions of title III) price support to producers for [21] tung nuts, honey,[22] milk, butterfat, and the products of milk and butterfat as follows:

(a) [21] * * *

(b) The price of tung nuts and honey,[22] respectively, shall be supported through loans, purchases, or other operations at a level not

[21] Sec. 709 of the Agricultural Act of 1954, 68 Stat. 899 (p. 173) deleted the reference to wool in the first sentence and repealed subsec. (a), which provided for price support on, wool, effective April 1, 1955. Beginning on that date, price support on wool has been made available under Title VII—National Wool Act of 1954 of the Agricultural Act of 1954 (p. 170.)

[22] Sec. 203 of the Agricultural Act of 1954, 68 Stat. 899, deleted references to potatoes in the first sentence and in subsection (b) and repealed section 5 of the Act of March 31, 1950, which prohibited price support on Irish potatoes unless marketing quotas were in effect.

in excess of 90 per centum nor less than 60 per centum of the parity price therefor: *Provided*, That in any crop year in which the Secretary determines that the domestic production of tung oil will be less than the anticipated domestic demand for such oil, the price of tung nuts shall be supported at not less than 65 per centum of the parity price therefor;[23]

(c) The price of whole milk, butterfat, and the products of such commodities, respectively, shall be supported at such levels not in excess of 90 per centum nor less than 75 per centum of the parity price therefor as the Secretary determines necessary in order to assure an adequate supply. Notwithstanding the foregoing provisions, for the period beginning with the enactment of this sentence and ending March 31, 1961, the price of milk for manufacturing purposes and the price of butterfat shall be supported at not less than $3.22 per hundredweight and 59.6 cents per pound, respectively. Such price support shall be provided through loans on, or purchases of, milk and the products of milk and butterfat, and for the period ending March 31, 1956, surplus stocks of dairy products owned by the Commodity Credit Corporation may be disposed of by any methods determined necessary by the Secretary. For the period beginning September 1, 1954, and ending June 30, 1955, not to exceed $50,000,000, and for the fiscal year ending June 30, 1956, not to exceed $60,000,000, and for each of the two fiscal years in the period beginning July 1, 1956, and ending June 30, 1958, not to exceed $75,000,000, of the funds of the Community Credit Corporation shall be used to increase the consumption of fluid milk by children in (1) nonprofit schools of high-school grade and under; and in (2) nonprofit nursery schools, child-care centers, settlement houses, summer camps, and similar nonprofit institutions devoted to the care and training of children.[24] (7 U.S.C. 1446.)

TRANSFER OF DAIRY PRODUCTS TO MILITARY AND VETERANS HOSPITALS

SEC. 202. [This section appears on p. 217 in the section entitled "Donations."]

SEC. 203. Whenever the price of either cottonseed or soybeans is supported under this Act, the price of the other shall be supported at such level as the Secretary determines will cause them to compete on equal terms on the market.[25] (7 U.S.C. 1446d.)

TITLE III—OTHER NONBASIC AGRICULTURAL COMMODITIES

SEC. 301. The Secretary is authorized to make available through loans, purchases, or other operations price support to producers for

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[23] Proviso added by sec. 503 of the Agricultural Act of 1958, 72 Stat. 996.

[24] The provisions of subsec. (c) were substituted for the previous provisions by sec. 204 (b) of the Agricultural Act of 1954, 68 Stat. 899. The last sentence was substituted by the Act of July 20, 1956, 70 Stat. 596, for the previous provision. A new sentence was added after the first sentence by the Act of September 16, 1960, 74 Stat. 1054.

For authority with respect to similar milk donation provisions in subsequent years see p. 218.

[25] Sec. 203 added by sec. 601 of the Agricultural Act of 1956, 70 Stat. 212. See also sec. 420 of this Act.

any nonbasic agricultural commodity [26] not designated in title II at a level not in excess of 90 per centum of the parity price for the commodity. (7 U.S.C. 1447.)

SEC. 302. Without restricting price support to those commodities for which a marketing quota or marketing agreement or order program is in effect, price support shall, insofar as feasible, be made available to producers of any storable nonbasic agricultural commodity for which such a program is in effect and who are complying with such program. The level of such support shall not be in excess of 90 per centum of the parity price of such commodity nor less than the level provided in the following table:

If the supply percentage as of the beginning of the marketing year is:

	The level of support shall be not less than the following percentage of the parity price:
Not more than 102	90
More than 102 but not more than 104	89
More than 104 but not more than 106	88
More than 106 but not more than 108	87
More than 108 but not more than 110	86
More than 110 but not more than 112	85
More than 112 but not more than 114	84
More than 114 but not more than 116	83
More than 116 but not more than 118	82
More than 118 but not more than 120	81
More than 120 but not more than 122	80
More than 122 but not more than 124	79
More than 124 but not more than 126	78
More than 126 but not more than 128	77
More than 128 but not more than 130	76
More than 130	75

Provided, That the level of price support may be less than the minimum level provided in the foregoing table if the Secretary, after examination of the availability of funds for mandatory price support programs and consideration of the other factors specified in section 401(b), determines that such lower level is desirable and proper. (7 U.S.C. 1448.)

SEC. 303. In determining the level of price support for any nonbasic agricultural commodity under this title, particular consideration shall be given to the levels at which the prices of competing agricultural commodities are being supported. (7 U.S.C. 1449.)

TITLE IV—MISCELLANEOUS

SUPPORT THROUGH CCC

SEC. 401. (a) The Secretary shall provide the price support authorized or required herein through the Commodity Credit Corporation and other means available to him. (7 U.S.C. 1421(a).)

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[26] For special provisions for flax grown on diverted acreage for 1964 and 1965, see sec. 339(c) of the Agricultural Adjustment Act of 1938, as amended (p. 67).

FACTORS

(b) Except as otherwise provided in this Act, the amounts, terms, and conditions of price support operations and the extent to which such operations are carried out, shall be determined or approved by the Secretary. The following factors shall be taken into consideration in determining, in the case of any commodity for which price support is discretionary, whether a price-support operation shall be undertaken and the level of such support and, in the case of any commodity for which price support is mandatory, the level of support in excess of the minimum level prescribed for such commodity: (1) the supply of the commodity in relation to the demand therefor, (2) the price levels at which other commodities are being supported and, in the case of feed grains, the feed values of such grains in relation to corn, (3) the availability of funds, (4) the perishability of the commodity, (5) the importance of the commodity to agriculture and the national economy, (6) the ability to dispose of stocks acquired through a price-support operation, (7) the need for offsetting temporary losses of export markets, (8) the ability and willingness of producers to keep supplies in line with demand, and (9),[27] in the case of upland cotton, changes in the cost of producing such cotton. (7 U.S.C. 1421(b).)

COMPLIANCE WITH ACREAGE ALLOTMENTS, GOALS, AND MARKETING PRACTICES

(c) [28] Compliance by the producer with acreage allotments, production goals and marketing practices (including marketing quotas when authorized by law), prescribed by the Secretary, may be required as a condition of eligibility for price support. In administering any program for diverted acres the Secretary may make his regulations applicable on an appropriate geographical basis. Such regulations shall be administered (1) in semiarid or other areas where good husbandry requires maintenance of a prudent feed reserve in such manner as to permit, to the extent so required by good husbandry, the production of forage crops for storage and subsequent use either on the farm or in feeding operations of the farm operator, and (2) in areas declared to be disaster areas by the President under Public Law 875, Eighty-first Congress, in such manner as will most quickly restore the normal pattern of their agriculture. (7 U.S.C. 1421(c).)

DETERMINATION OF SUPPORT LEVEL

(d) The level of price support for any commodity shall be determined upon the basis of its parity price as of the beginning of the marketing year or season in the case of any commodity marketed on a marketing year or season basis and as of January 1 in the case of any other commodity. (7 U.S.C. 1421(d).)

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[27] Clause (9) was added by Pub. L. 88–297, 78 Stat. 175, approved April 11, 1964.
[28] Language in subsec. after the first sentence was added by sec. 206 of the Agricultural Act of 1954, 68 Stat. 901.

PROCESSOR PROGRAMS

(e) [29] Whenever any price support or surplus removal operation for any agricultural commodity is carried out through purchases from or loans or payments to processors, the Secretary shall, to the extent practicable, obtain from the processors such assurances as he deems adequate that the producers of the agricultural commodity involved have received or will receive maximum benefits from the price support or surplus removal operation. (7 U.S.C. 1421(e).)

SUPPORT AT INCREASED LEVEL

SEC. 402. Notwithstanding any other provisions of this Act, price support at a level in excess of the maximum level of price support otherwise prescribed in this Act may be made available for any agricultural commodity if the Secretary determines, after a public hearing of which reasonable notice has been given, that price support at such increased level is necessary in order to prevent or alleviate a shortage in the supply of any agricultural commodity essential to the national welfare or in order to increase or maintain the production of any agricultural commodity in the interest of national security. The Secretary's determination and the record of the hearing shall be available to the public. (7 U.S.C. 1422.)

ADJUSTMENTS FOR GRADE, ETC.

SEC. 403.[30] Appropriate adjustments may be made in the support price for any commodity for differences in grade, type, staple, quality, location, and other factors. Such adjustments shall, so far as practicable, be made in such manner that the average support price for such commodity will, on the basis of the anticipated incidence of such factors, be equal to the level of support determined as provided in this Act. Beginning with the 1959 crop, in adjusting the support price for cotton on the basis of grade, the Secretary shall establish separate price support rates for split grades and for full grades substantially reflecting relative values.[31] (7 U.S.C. 1423.)

UTILIZATION OF SERVICES AND FACILITIES OF CCC

SEC. 404. The Secretary, in carrying out programs under section 32 of Public Law Numbered 320, Seventy-fourth Congress, approved August 24, 1935, as amended, and section 6 of the National School Lunch Act may utilize the services and facilities of the Commodity Credit Corporation (including but not limited to procurement by contract), and make advance payments to it. (7 U.S.C. 1424.)

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[29] Subsec. (e) added by sec. 207 of the Agricultural Act of 1954, 68 Stat. 901.

[30] As originally enacted this section contained as its third sentence the following: "Middling seven-eighths-inch cotton shall be the Standard in this Act." This sentence was repealed effective with the 1961 crop by sec. 108 of the Agricultural Act of 1958, 72 Stat. 993.

[31] Last sentence added by sec. 111 of the Agricultural Act of 1958, 72 Stat. 993.

NONRECOURSE LOANS

SEC. 405. No producer shall be personally liable for any deficiency arising from the sale of the collateral securing any loan made under authority of this Act unless such loan was obtained through fraudulent representations by the producer. This provision shall not, however, be construed to prevent the Commodity Credit Corporation or the Secretary from requiring producers to assume liability for deficiencies in the grade, quality, or quantity of commodities stored on the farm or delivered by them, for failure properly to care for and preserve commodities, or for failure or refusal to deliver commodities in accordance with the requirements of the program. There is authorized to be included in the terms and conditions of any such nonrecourse loan a provision whereby on and after the maturity of the loan or any extension thereof Commodity Credit Corporation shall have the right to acquire title to the unredeemed collateral without obligation to pay for any market value which such collateral may have in excess of the loan indebtedness.[32] (7 U.S.C. 1425.)

ADVANCE ANNOUNCEMENT

SEC. 406. The Secretary shall, insofar as practicable, announce the level of price support for field crops in advance of the planting season and for other agricultural commodities in advance of the beginning of the marketing year or season (January 1 in the case of commodities not marketed on a marketing year or season basis), but the level of price support so announced shall not exceed the estimated maximum level of price support specified in this Act, based upon the latest information and statistics available to the Secretary when such level of price support is announced; and the level of price support so announced shall not be reduced if the maximum level of price support when determined, is less than the level so announced. (7 U.S.C. 1426.)

RESTRICTIONS ON SALES BY CCC

SEC. 407.[33] The Commodity Credit Corporation may sell any farm commodity owned or controlled by it at any price not prohibited by this section. In determining sales policies for basic agricultural commodities or storable nonbasic commodities, the Corporation should give consideration to the establishing of such policies with respect to prices, terms, and conditions as it determines will not discourage or deter manufacturers, processors, and dealers from acquiring and carrying normal inventories of the commodity of the current crop. The Corporation shall not sell any basic agricultural commodity or storable nonbasic commodity at less than 5 per centum above the current support price for such commodity, plus reasonable carrying charges: *Provided*,[34] That effective with the beginning of the marketing year for the 1961 crop, the Corporation shall not sell any upland or extra long staple cotton for unrestricted use at less than 15 per centum

[32] Last sentence added by sec. 502 of the Agricultural Act of 1958, 72 Stat. 996.
[33] 63 Stat. 1055, October 31, 1949.
[34] This proviso was added by sec. 109 of the Agricultural Act of 1958, 72 Stat. 993.

above the current support price for cotton plus reasonable carrying charges, except that the Corporation may, in an orderly manner and so as not to affect market prices unduly, sell for unrestricted use at the market price at the time of sale a number of bales of cotton equal to the number of bales by which the national marketing quota for such marketing year is reduced below the estimated domestic consumption and exports for such marketing year pursuant to the provisions of section 342 of the Agricultural Adjustment Act of 1938, as amended: *Provided further*[35] That beginning August 1, 1964, the Commodity Credit Corporation may sell upland cotton for unrestricted use at not less than 105 per centum of the current loan rate for such cotton under section 103(a) plus reasonable carrying charges: *Provided*,[36] That if a wheat marketing allocation program is in effect, the current support price for wheat shall be the support price for wheat accompanied by marketing certificate and wheat sold shall be accompanied by a marketing certificate.

[SEC. 204 of Pub. L. 88–297, 78 Stat. 183, approved April 11, 1964, provides that effective only with respect to the marketing years beginning in the calendar years 1964 and 1965, the preceding proviso is amended to read as follows: "*Provided further*, That if a wheat marketing allocation program is in effect, the current support price for wheat shall be the support price for wheat not accompanied by marketing certificates."]

The foregoing restrictions shall not apply to (A) sales for new or byproduct uses; (B) sales of peanuts and oilseeds for the extraction of oil; (C) sales for seed or feed if such sales will not substantially impair any price-support program; (D) sales of commodities which have substantially deteriorated in quality or as to which there is a danger of loss or waste through deterioration or spoilage; (E) sales for the purpose of establishing claims arising out of contract or against persons who have committed fraud, misrepresentation, or other wrongful acts with respect to the commodity; (F) sales for export; (G) sales of wool; and (H) sales for other than primary uses. Notwithstanding the foregoing, the Corporation, on such terms and conditions as the Secretary may deem in the public interest, shall make available any farm commodity or product thereof owned or controlled by it for use in relieving distress (1) in any area in the United States including the Virgin Islands[37] declared by the President to be an acute distress area because of unemployment or other economic cause if the President finds that such use will not displace or interfere with normal marketing of agricultural commodities and (2) in connection with any major disaster determined by the President to warrant assistance by the Federal Government under Public Law 875, Eighty-first Congress, as amended (42 U.S.C. 1855)[38] and shall make feed owned or controlled by it available at any price not less than 75 per centum of the current basic county support rate for such feed including the value of any applicable price support payment in kind (or a

[35] This proviso was added by Pub. L. 88–297, 78 Stat. 175, approved April 11, 1964.
[36] This proviso was added by sec. 325 of the Food and Agriculture Act of 1962, 76 Stat. 631.
[37] The words "including the Virgin Islands" were added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.
[38] See Act of September 21, 1959, 73 Stat. 574 (p. 227).

comparable price if there is no current basic county support rate) for assistance in the preservation and maintenance of foundation herds of cattle (including producing dairy cattle), sheep, and goats, and their offspring, in any area of the United States including the Virgin Islands [37] where, because of flood, drought, fire, hurricane, earthquake, storm, disease, insect infestation, or other catastrophe in such areas, the Secretary determines that an emergency exists which warrants such assistance, such feed to be made available only to persons who do not have, and are unable to obtain through normal channels of trade without undue financial hardship, sufficient feed for such livestock: *Provided*, That the Secretary may provide for the furnishing of feed or mixed feed, in accordance with regulations prescribed by him, to such persons by feed dealers under an arrangement whereby the feed grains (or other feed being sold by the Corporation) in the feed so furnished would be replaced with feed owned or controlled by the Corporation and sold to such persons at a price determined as provided above.[39] Except on a reimbursable basis, the Corporation shall not bear any costs in connection with making such commodity available beyond the cost of the commodities to the Corporation in store and the handling and transportation costs in making delivery of the commodity to designated agencies at one or more central locations in each State or other area.[40] Nor shall the foregoing restrictions apply to sales of commodities the disposition of which is desirable in the interest of the effective and efficient conduct of the Corporation's operations because of the small quantities involved, or because of age, location or questionable continued storability, but such sales shall be offset by such purchases of commodities as the Corporation determines are necessary to prevent such sales from substantially impairing any price-support program, but in no event shall the purchase price exceed the then current support price for such commodities.[41] For the purposes of this section, sales for export shall not only include sales made on condition that the identical commodities sold be exported, but shall also include sales made on condition that commodities of the same kind and of comparable value or quantity be exported, either in raw or processed form.[42] Notwithstanding the foregoing, whenever prior to December 31, 1963, the Secretary determines it necessary in order to assure the Nation an adequate supply of milk free of contamination by radioactive fallout, he may make feed owned or controlled by the Commodity Credit Corporation available to producers of milk in any area or areas of the United States at such prices and on such terms and conditions as he deems appropriate in the public interest.[43] (7 U.S.C. 1427.)

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[39] The language appearing after "(42 U.S.C. 1855)" was added by the Act of August 7, 1961, 75 Stat. 203, and was further amended by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964, by adding the proviso.

[40] The words "or other area" were added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964, by adding this proviso.

[41] This sentence was added by the Act of July 29, 1954, 68 Stat. 583.

[42] This sentence was added by the Act of January 28, 1956, 70 Stat. 6.

[43] This last sentence was added by sec. 404 of the Food and Agriculture Act of 1962, 76 Stat. 632.

DEFINITIONS

SEC. 408. For the purposes of this Act—

STORABLE COMMODITIES

(a) A commodity shall be considered storable upon determination by the Secretary that, in normal trade practice, it is stored for substantial periods of time and that it can be stored under the price-support program without excessive loss through deterioration or spoilage or without excessive cost for storage for such periods as will permit its disposition without substantial impairment of the effectiveness of the price-support program. (7 U.S.C. 1428(a).)

COOPERATOR

(b) [44] A "cooperator" with respect to any basic agricultural commodity shall be a producer on whose farm the acreage planted to the commodity does not exceed the farm acreage allotment for the commodity under title III of the Agricultural Adjustment Act of 1938, as amended, or in the case of price support for corn or wheat to a producer outside the commercial corn-producing or wheat-producing area, a producer who complies with conditions of eligibility prescribed by the Secretary. For the purpose of this subsection, a producer shall not be deemed to have exceeded his farm acreage allotment unless such producer knowingly exceeded such allotment.[45] (7 U.S.C. 1428(b).)

BASIC AGRICULTURAL COMMODITY

(c) A "basic agricultural commodity" shall mean corn, cotton, peanuts, rice, tobacco, and wheat, respectively. (7 U.S.C. 1428(c).)

NONBASIC AGRICULTURAL COMMODITY

(d) A "nonbasic agricultural commodity" shall mean any agricultural commodity other than a basic agricultural commodity. (7 U.S.C. 1428(d).)

SUPPLY PERCENTAGE

(e) The "supply percentage" as to any commodity shall be the percentage which the estimated total supply is of the normal supply as determined by the Secretary from the latest available statistics of the Department of Agriculture as of the beginning of the marketing year for the commodity. (7 U.S.C. 1428(e).)

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[44] The words "or wheat" and "or wheat-producing" were added by sec. 209 of the Agricultural Act of 1954, 68 Stat. 901.

[45] See sec. 374(c) of the Agricultural Adjustment Act of 1938 as to adjusting planted acreage.

TOTAL SUPPLY

(f) "Total supply" [46] of any nonbasic agricultural commodity for any marketing year shall be the carry-over at the beginning of such marketing year, plus the estimated production of the commodity in the United States during the calendar year in which such marketing year begins and the estimated imports of the commodity into the United States during such marketing year. (7 U.S.C. 1428(f).)

CARRY-OVER

(g) "Carry-over" [46] of any nonbasic agricultural commodity for any marketing year shall be the quantity of the commodity on hand in the United States at the beginning of such marketing year, not including any part of the crop or production of such commodity which was produced in the United States during the calendar year then current. The carry-over of any such commodity may also include the quantity of such commodity in processed form on hand in the United States at the beginning of such marketing year, if the Secretary determines that the inclusion of such processed quantity of the commodity is necessary to effectuate the purposes of this Act. (7 U.S.C. 1428(g).)

NORMAL SUPPLY

(h) "Normal supply" [46] of any nonbasic agricultural commodity for any marketing year shall be (1) the estimated domestic consumption of the commodity for the marketing year for which such normal supply is being determined, plus (2) the estimated exports of the commodity for such marketing year, plus (3) an allowance for carry-over. The allowance for carry-over shall be the average carry-over of the commodity for the five marketing years immediately preceding the marketing year in which such normal supply is determined, adjusted for surpluses or deficiencies caused by abnormal conditions, changes in marketing conditions, or the operation of any agricultural program. In determining normal supply, the Secretary shall make such adjustments for current trends in consumption and for unusual conditions as he may deem necessary. (7 U.S.C. 1428(h).)

MARKETING YEAR

(i) "Marketing year" [46] for any nonbasic agricultural commodity means any period determined by the Secretary during which substantially all of the crop or production of such commodity is normally marketed by the producers thereof. (7 U.S.C. 1428(i).)

TERMS DEFINED IN AGRICULTURAL ADJUSTMENT ACT OF 1938

(j) Any term defined in the Agricultural Adjustment Act of 1938, shall have the same meaning when used in this Act. (7 U.S.C. 1428(j).)

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[46] See sec. 301(b) of the Agricultural Adjustment Act of 1938 for definitions applicable to basic commodities.

SEC. 409. [This section contains amendments to the Agricultural Adjustment Act of 1938. These amendments are included in that Act, as it appears in this compilation.]

SEC. 410. [This section contains an amendment to section 4 of the Act of March 8, 1938 (15 U.S.C. 713a–4) relating to the borrowing power of Commodity Credit Corporation (p. 233).]

SEC. 411. [This section contains an amendment to section 32 of Pub. L. 320, 74th Congress (p. 211).]

DETERMINATIONS BY SECRETARY

SEC. 412. Determinations made by the Secretary under this Act shall be final and conclusive: *Provided*, That the scope and nature of such determinations shall not be inconsistent with the provisions of the Commodity Credit Corporation Charter Act. (7 U.S.C. 1429.)

WHEN PRICE SUPPORT PROVISIONS EFFECTIVE

SEC. 413. This Act shall not be effective with respect to price support operations for any agricultural commodity for any marketing year or season commencing prior to January 1, 1950, except to the extent that the Secretary of Agriculture shall, without reducing price support theretofore undertaken or announced, elect to apply the provisions of this Act. (7 U.S.C. 1430.)

REPEAL OF PREVIOUS LEGISLATION

SEC. 414. Section 302 of the Agricultural Adjustment Act of 1938, as amended, and any provision of law in conflict with the provisions of this Act are hereby repealed. (7 U.S.C. 1421 note.)

SEC. 415. [This section contains amendments to the Agricultural Act of 1948 and the Agricultural Adjustment Act of 1938.]

DISPOSITION OF COMMODITIES TO PREVENT WASTE

SEC. 416.[47] In order to prevent the waste of commodities whether in private stocks or [48] acquired through price-supported operations by the Commodity Credit Corporation before they can be disposed of in normal domestic channels without impairment of the price-support program or sold abroad at competitive world prices, the Commodity Credit Corporation is authorized, on such terms and under such regulations as the Secretary may deem in the public interest: (1) upon application, to make such commodities available to any Federal agency for use in making payment for commodities not produced in the United States; (2) to barter or exchange such commodities for strategic or

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[47] The provisions of this section were substituted for the previous provisions by sec. 302 of the Agricultural Trade Development and Assistance Act of 1954, 68 Stat. 458. See sec. 9 of the Act of September 6, 1958, 72 Stat. 1792 and the Department of the Interior and Related Agencies Appropriation Act, 1965 (both on p. 215), providing for distribution of commodities under sec. 416 to overseas areas under the jurisdiction or administration of the United States. See also sec. 305 of the Agricultural Trade Development and Assistant Act of 1954, providing for the identification of stocks disposed of under sec. 416 as being furnished by the people of the United States.

[48] The words "whether in private stocks or" were added by the Act of July 24, 1959, 73 Stat. 250.

other materials as authorized by law; (3) in the case of food commodities to donate such commodities to the Bureau of Indian Affairs and to such State, Federal, or private agency or agencies as may be designated by the proper State or Federal authority and approved by the Secretary, for use in the United States in nonprofit school-lunch programs,[49] in nonprofit summer camps for children,[50] in the assistance of needy persons, and in charitable institutions, including hospitals, to the extent that needy persons are served; and (4) to donate any such food commodities in excess of anticipated disposition under (1), (2), and (3) above to nonprofit voluntary agencies registered with the Committee on Voluntary Foreign Aid of the Foreign Operations Administration or other appropriate department or agency of the Federal Government and intergovernmental organizations for use in the assistance of needy persons and in nonprofit school lunch programs [51] outside the United States. In the case of (3) and (4) above the Secretary shall obtain such assurance as he deems necessary that the recipients thereof will not diminish their normal expenditures for food by reason of such donation. In order to facilitate the appropriate disposal of such commodities, the Secretary may from time to time estimate and announce the quantity of such commodities which he anticipates will become available for distribution under (3) and (4) above. The Commodity Credit Corporation may pay, with respect to commodities disposed of under this section, reprocessing, packaging, transporting, handling, and other charges accruing up to the time of their delivery to a Federal agency or to the designated State or private agency, in the case of commodities made available for use within the United States, or their delivery free alongside ship or free on board export carrier at point of export, in the case of commodities made available for use outside the United States. In addition, in the case of food commodities disposed of under this section, the Commodity Credit Corporation may pay the cost of processing such commodities into a form suitable for home or institutional use, such processing to be accomplished through private trade facilities to the greatest extent possible.[52] For the purpose of this section the terms "State" and "United States" include the District of Columbia and any Territory or possession of the United States. The assistance to needy persons provided in (4) above shall, insofar as practicable be directed toward community and other self-help activities designed to alleviate the causes of the need for such assistance.[53] (7 U.S.C. 1431.)

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[49] See Act of September 13, 1960, 74 Stat. 899 (p. 220) authorizing the use of surplus foods for training home economics students.

[50] The words "in nonprofit summer camps for children," were added by the Act of July 2, 1958, 72 Stat. 286.

[51] The phrase "and in nonprofit school lunch programs" was added by Food and Agriculture Act of 1962, 76 Stat. 611, September 27, 1962.

[52] This sentence was added by the Agricultural Act of 1956, 70 Stat. 203.

[53] This sentence was added by Pub. L. 88–638, 78 Stat. 1038, approved October 8, 1964.

STORAGE STRUCTURE LOANS TO COOPERATIVES

SEC. 417. (a) Section 41 of the Farm Credit Act of 1933 (U.S.C., title 12, sec. 1134c) is amended by adding at the end thereof the following:

"Notwithstanding any limitations or conditions imposed by law, but subject to the availability of funds, each Bank for Cooperatives shall have power and authority to make separate loans to cooperative associations as defined in the Agricultural Marketing Act, as amended, for the purpose of financing the construction of structures for the storage of agricultural commodities (other than structures to provide refrigerated cold storage or structures in areas in which existing privately owned storage facilities for the commodity concerned are adequate) in amounts up to a maximum of 80 per centum of the cost of such structures, as approved by the Bank for cooperatives to whom application is made for the loan: *Provided*, That the cooperative association which has applied for any loan shall have furnished to the Bank for Cooperatives an appropriate commitment from the Commodity Credit Corporation that the Commodity Credit Corporation will lease or guarantee utilization of not less than 75 per centum of the storage space contained in such structures when completed for a period of at least three years if such structures are not additions to existing structures, or two years if such structures are additions to existing structures."

(b) Section 34 of the Farm Credit Act of 1933 (U.S.C., title 12, sec. 1134j) is amended by adding at the end thereof the following:

"Notwithstanding any limitations or conditions imposed by law, but subject to the availability of funds, the Central Bank for Cooperatives shall have power and authority to make separate loans to cooperative associations as defined in the Agricultural Marketing Act, as amended, for the purpose of financing the construction of structures for the storage of agricultural commodities (other than structures to provide refrigerated cold storage or structures located in areas in which existing privately owned storage facilities for the commodity concerned are adequate) in amounts up to a maximum of 80 per centum of the cost of such structures, as approved by such bank: *Provided*, That the cooperative association which has applied for any loan shall have furnished to such bank an appropriate commitment from the Commodity Credit Corporation that the Commodity Credit Corporation will lease or guarantee utilization of not less than 75 per centum of the storage space contained in such structures when completed for a period of at least three years if such structures are not additions to existing structures, or two years if such structures are additions to existing structures." [54]

SECS. 418 and 419. [These sections contain amendments to the Agricultural Adjustment Act of 1938. These amendments are included in that Act as it appears in this compilation.]

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[54] See also sec. 4(h) of the Commodity Credit Corporation Charter Act (p. 136), which provides for loans by the Corporation to grain growers to finance the construction or purchase of storage facilities.

PRICE SUPPORT FOR COTTONSEED

SEC. 420.[55] Any price support program in effect on cottonseed or any of its products shall be extended to the same seed and products of the cottons defined under section 347(a) of the Agricultural Adjustment Act of 1938, as amended. (7 U.S.C. 1432.)

SEC. 421. [This section was added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964. It appears on p. 228.]

TITLE V—AGRICULTURAL WORKERS

[This title, which was added by the Act of July 12, 1951, 65 Stat. 119, 7 U.S.C. 1461–1468, contained provisions authorizing the Secretary of Labor to enter into arrangements for the recruiting of agricultural workers from Mexico. Pub. L. 88–203, 77 Stat. 363, approved December 13, 1963, however, terminated such authority effective December 31, 1964.]

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[55] This section was added by the Act of July 17, 1952, 66 Stat. 259. See also sec. 203 of this Act.

AGRICULTURAL ACT OF 1954[1]

AN ACT

To provide for greater stability in agriculture; to augment the marketing and disposal of agricultural products; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled.

TITLE I—SET ASIDE OF AGRICULTURAL COMMODITIES

[This title is no longer in effect since the set aside and disposition of the commodities involved have been completed as required. See p. 148 of Agriculture Handbook No. 192 for the text.]

TITLE II—AMENDMENTS TO AGRICULTURAL ACT OF 1949, AS AMENDED, AND RELATED LEGISLATION

[This title contains amendments to the Agricultural Act of 1949, which are incorporated in that Act as contained in this compilation, and amendments to related legislation.]

TITLE III—AMENDMENTS TO AGRICULTURAL ADJUSTMENT ACT OF 1938, AND RELATED LEGISLATION

[This title contains amendments to the Agricultural Act of 1949 and the Agricultural Adjustment Act of 1938, which are incorporated in those Acts contained in this compilation, and amendments to related legislation.]

TITLE IV—AMENDMENTS TO AGRICULTURAL MARKETING AGREEMENT ACT OF 1937

[This title contains amendments to the Agricultural Marketing Agreement Act of 1937, which are incorporated in that Act as contained in this compilation.]

TITLE V—AMENDMENTS TO SOIL CONSERVATION AND DOMESTIC ALLOTMENT ACT

[This title contains amendments to the Soil Conservation and Domestic Allotment Act, which are incorporated in that Act as contained in this compilation.]

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[1] Approved August 28, 1954, 68 Stat. 897.

TITLE VI—AGRICULTURAL ATTACHÉS

[This title appears on p. 329 in the Miscellaneous Laws Section.]

TITLE VII—NATIONAL WOOL ACT OF 1954

SEC. 701. This title may be cited as the "National Wool Act of 1954."

SEC. 702. It is hereby recognized that wool is an essential and strategic commodity which is not produced in quantities and grades in the United States to meet the domestic needs and that the desired domestic production of wool is impaired by the depressing effects of wide fluctuations in the price of wool in the world markets. It is hereby declared to be the policy of Congress, as a measure of national security and in promotion of the general economic welfare, to encourage the annual domestic production of approximately three hundred million pounds of shorn wool, grease basis, at prices fair to both producers and consumers in a manner which will have the least adverse effects upon foreign trade. (7 U.S.C. 1781.)

SEC. 703. The Secretary of Agriculture shall, through the Commodity Credit Corporation, support the prices of wool and mohair, respectively, to the producers thereof by means of loans, purchases, payments, or other operations. Such price support shall be limited to wool and mohair marketed during the period beginning April 1, 1955, and ending March 31, 1966.[2] The support price for shorn wool shall be at such incentive level as the Secretary, after consultation with the producer representatives, and after taking into consideration prices paid and other cost conditions affecting sheep production, determines to be necessary in order to encourage an annual production consistent with the declared policy of this title: *Provided*, That the support price for shown wool shall not exceed 110 per centum of the parity price therefor. If the support price so determined does not exceed 90 per centum of the parity price for shorn wool, the support price for shorn wool shall be at such level, not in excess of 90 per centum nor less than 60 per centum of the parity price therefor, as the Secretary determines necessary in order to encourage an annual production of approximately three hundred and sixty million pounds of shorn wool. The support prices for pulled wool and for mohair shall be established at such levels, in relationship to the support price for shorn wool, as the Secretary determines will maintain normal marketing practices for pulled wool, and as the Secretary shall determine is necessary to maintain approximately the same percentage of parity for mohair as for shorn wool. The deviation of mohair support prices shall not be calculated so as to cause it to rise or fall more than 15 per centum above or below the comparable percentage of parity at which shorn wool is supported. Notwithstanding the foregoing, no price support shall be made available, other than through payments, at a level in excess of 90 per centum of the parity price for the commodity. The Secretary shall, to the extent practicable, announce the support price levels for wool and mohair sufficiently in advance of each marketing

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[2] "1966" substituted for "1962" by sec. 151 of the Agricultural Act of 1961, 75 Stat. 306, August 8, 1961.

year as will permit producers to plan their production for such marketing year. (7 U.S.C. 1782.)

SEC. 704. If payments are utilized as a means of price support, the payments shall be such as the Secretary of Agriculture determines to be sufficient, when added to the national average price received by producers, to give producers a national average return for the commodity equal to the support price level therefor: *Provided*, That the total of all such payments made under this Act shall not at any time exceed an amount equal to 70 per centum of the accumulated totals, as of the same date, of the gross receipts from duties [3] collected on and after January 1, 1953, on all articles subject to duty under schedule 11 of the Tariff Act of 1930, as amended. The payments shall be made upon wool and mohair marketed by the producers thereof, but any wool or mohair produced prior to January 1, 1955, shall not be the subject of payments. The payments shall be at such rates for the marketing year or periods thereof as the Secretary determines will give producers the support price level as herein provided. Payments to any producer need not be made if the Secretary determines that the amount of the payment to the producer or all producers is too small to justify the cost of making such payments. The Secretary may make the payment to producers through the marketing agency to or through whom the producers marketed his wool or mohair: *Provided*, That such marketing agency agrees to receive and promptly distribute the payments on behalf of such producers. In case any person who is entitled to any such payment dies, becomes incompetent, or disappears before receiving such payment, or is succeeded by another who renders or completes the required performance, the payment shall, without regard to any other provisions of law, be made as the Secretary may determine to be fair and reasonable in all the circumstances and provided by regulation. (7 U.S.C. 1783.)

SEC. 705. For the purpose of reimbursing the Commodity Credit Corporation for any expenditures made by it in connection with payments to producers under this title, there is hereby appropriated for each fiscal year beginning with the fiscal year ending June 30, 1956, an amount equal to the total of expenditures made by the Corporation during the preceding fiscal year and to any amounts expended in prior fiscal years not previously reimbursed: *Provided, however*, That such amounts appropriated for any fiscal year shall not exceed 70 per centum of the gross receipts from duties [3] collected during the period January 1 to December 31, both inclusive, preceding the beginning of each such fiscal year on all articles subject to duty under schedule 11 of the Tariff Act of 1930, as amended. For the purposes of the appraisal under the Act of March 8, 1938, as amended (15 U.S.C. 713a–1), the Commodity Credit Corporation shall establish on its books an account receivable in an amount equal to any amount expended by Commodity Credit Corporation in connection with payments pursuant to this title which has not been reimbursed from appropriations made hereunder. (7 U.S.C. 1784.)

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[3] Secs. 402 and 403 of the Agricultural Act of 1958, 72 Stat. 995, deleted "specific" prior to and "(whether or not such specific duties are parts of compound rates)" following, the word duties.

SEC. 706. Except as otherwise provided in this title, the amounts, terms, and conditions of the price support operations and the extent to which such operations are carried out shall be determined or approved by the Secretary of Agriculture. The Secretary may, in determining support prices and rates of payment, make adjustments in such prices or rates for differences in grade, quality, type, location, and other factors to the extent he deems practicable and desirable. Determinations by the Secretary under this title shall be final and conclusive. The facts constituting the basis for any operation, payment, or amount thereof when officially determined in conformity with applicable regulations prescribed by the Secretary shall be final and conclusive and shall not be reviewable by any other officer or agency of the Government. (7 U.S.C. 1785.)

SEC. 707. The term "marketing year" as used in this title means the twelve-month period beginning April 1 of each calendar year or, for either wool or mohair, such other period, or periods for prescribed areas, as the Secretary may determine to be desirable to effectuate the purpose of this title. (7 U.S.C. 1786.)

SEC. 708. The Secretary of Agriculture is authorized to enter into agreements with, or to approve agreements entered into between, marketing cooperatives, trade associations, or others engaged or whose members are engaged in the handling of wool, mohair, sheep, or goats or the products thereof for the purpose of developing and conducting on a National, State, or regional basis advertising and sales promotion programs for wool, mohair, sheep, or goats or the products thereof. Provision may be made in such agreement to obtain the funds necessary to defray the expenses incurred thereunder through pro rata deductions from the payments made under section 704 of this title to producers within the production area he determines will be benefited by the agreement and for the assignment and transfer of the amounts so deducted to the person or agency designated in the agreement to receive such amounts for expenditures in accordance with the terms and conditions of the agreement. No agreement containing such a provision for defraying expenses through deductions shall become effective until the Secretary determines that at least two-thirds of the producers who, during a representative period determined by the Secretary, have been engaged, within the production area he determines will be benefited by the agreement, in the production for market of the commodity specified therein approve or favor such agreement or that producers who, during such representative period have produced at least two-thirds of the volume of such commodity produced within the area which will be benefited by such agreement, approve or favor such agreement. Approval or disapproval by cooperative associations shall be considered as approval or disapproval by the producers who are members of, stockholders in, or under contract with such cooperative association of producers. The Secretary may conduct a referendum among producers to ascertain their approval or favor. The requirements of approval or favor shall be held to be complied with if two-thirds of the total number of producers, or two-thirds of the total volume of production, as the case may be,

represented in such referendum, indicate their approval or favor. (7 U.S.C. 1787.)

SEC. 709. Section 201 of the Agricultural Act of 1949 (7 U.S.C. sec. 1446) is amended effective April 1, 1955, (i) by deleting from the first sentence thereof the phrase "wool (including mohair)," and (ii) by deleting subsection (a) thereof relating to the support of wool and mohair.

SEC. 710. [This section contains an amendment to the Commodity Exchange Act.]

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SUBPART C. SALES

[See Subpart E. Export and Surplus Removal for export sales p. 183.]

SALES IN GENERAL

Agricultural Act of 1949—Sec. 407.[1] The Commodity Credit Corporation may sell any farm commodity owned or controlled by it at any price not prohibited by this section. In determining sales policies for basic agricultural commodities or storable nonbasic commodities, the Corporation should give consideration to the establishing of such policies with respect to prices, terms, and conditions as it determines will not discourage or deter manufacturers, processors, and dealers from acquiring and carrying normal inventories of the commodity of the current crop. The Corporation shall not sell any basic agricultural commodity or storable nonbasic commodity at less than 5 per centum above the current support price for such commodity, plus reasonable carrying charges: *Provided*,[2] That effective with the beginning of the marketing year for the 1961 crop, the Corporation shall not sell any upland or extra long staple cotton for unrestricted use at less than 15 per centum above the current support price for cotton plus reasonable carrying charges, except that the Corporation may, in an orderly manner and so as not to affect market prices unduly, sell for unrestricted use at the market price at the time of sale a number of bales of cotton equal to the number of bales by which the national marketing quota for such marketing year is reduced below the estimated domestic consumption and exports for such marketing year pursuant to the provisions of section 342 of the Agricultural Adjustment Act of 1938, as amended: *Provided further*,[3] That beginning August 1, 1964, the Commodity Credit Corporation may sell upland cotton for unrestricted use at not less than 105 per centum of the current loan rate for such cotton under section 103(a) plus reasonable carrying charges: *Provided*,[4] That if a wheat marketing allocation program is in effect, the current support price for wheat shall be the support price for wheat accompanied by marketing certificate and wheat sold shall be accompanied by a marketing certificate.

[Sec. 204 of Pub. L. 88–297, 78 Stat. 183, approved April 11, 1964, provides that effective only with respect to the marketing years beginning in the calendar years 1964 and 1965, the preceding proviso is amended to read as follows: "*Provided further, That if a wheat marketing allocation program is in effect, the current support price for wheat shall be the support price for wheat not accompanied by marketing certificates.*"]

The foregoing restrictions shall not apply to (A) sales for new or byproduct uses; (B) sales of peanuts and oilseeds for the extraction

[1] 63 Stat. 1055, October 31, 1949.
[2] This proviso was added by sec. 109 of the Agricultural Act of 1958, 72 Stat. 993.
[3] This proviso was added by Pub. L. 88–297, 78 Stat. 175, approved April 11, 1964.
[4] This proviso was added by sec. 325 of the Food and Agriculture Act of 1962, 76 Stat. 631.

of oil; (C) sales for seed or feed if such sales will not substantially impair any price-support program; (D) sales of commodities which have substantially deteriorated in quality or as to which there is a danger of loss or waste through deterioration or spoilage; (E) sales for the purpose of establishing claims arising out of contract or against persons who have committed fraud, misrepresentation, or other wrongful acts with respect to the commodity; (F) sales for export; (G) sales of wool; and (H) sales for other than primary uses. Notwithstanding the foregoing, the Corporation, on such terms and conditions as the Secretary may deem in the public interest, shall make available any farm commodity or product thereof owned or controlled by it for use in relieving distress (1) in any area in the United States including the Virgin Islands [5] declared by the President to be an acute distress area because of unemployment or other economic cause if the President finds that such use will not displace or interfere with normal marketing of agricultural commodities and (2) in connection with any major disaster determined by the President to warrant assistance by the Federal Government under Public Law 875, Eighty-first Congress, as amended (42 U.S.C. 1855) [6] and shall make feed owned or controlled by it available at any price not less than 75 per centum of the current basic county support rate for such feed including the value of any applicable price support payment in kind (or a comparable price if there is no current basic county support rate) for assistance in the preservation and maintenance of foundation herds of cattle (including producing dairy cattle), sheep, and goats, and their offspring, in any area of the United States including the Virgin Islands [5] where, because of flood, drought, fire, hurricane, earthquake, storm, disease, insect infestation, or other catastrophe in such areas, the Secretary determines that an emergency exists which warrants such assistance, such feed to be made available only to persons who do not have, and are unable to obtain through normal channels of trade without undue financial hardship, sufficient feed for such livestock: *Provided*, That the Secretary may provide for the furnishing of feed or mixed feed, in accordance with regulations prescribed by him, to such persons by feed dealers under an arrangement whereby the feed grains (or other feed being sold by the Corporation) in the feed so furnished would be replaced with feed owned or controlled by the Corporation and sold to such persons at a price determined as provided above.[7] Except on a reimbursable basis, the Corporation shall not bear any costs in connection with making such commodity available beyond the cost of the commodities to the Corporation in store and the handling and transportation costs in making delivery of the commodity to designated agencies at one or more central locations in each State or other area.[8] Nor shall the foregoing restrictions apply to sales of commodities the disposition of which is desirable in the interest of the effective and

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[5] The words "including the Virgin Islands" were added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.

[6] See Pub. L. 86–299, 73 Stat. 574, approved September 21, 1959 (p. 227).

[7] The language appearing after "(42 U.S.C. 1855)" was added by the Act of August 7, 1961, 75 Stat. 203, 204, and was further amended by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964, by adding this proviso.

[8] The words "or other area" were added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.

efficient conduct of the Corporation's operations because of the small quantities involved, or because of age, location or questionable continued storability, but such sales shall be offset by such purchases of commodities as the Corporation determines are necessary to prevent such sales from substantially impairing any price-support program, but in no event shall the purchase price exceed the then current support price for such commodities.[9] For the purposes of this section, sales for export shall not only include sales made on condition that the identical commodities sold be exported, but shall also include sales made on condition that commodities of the same kind and of comparable value or quantity be exported, either in raw or processed form.[10] Notwithstanding the foregoing, whenever prior to December 31, 1963, the Secretary determines it necessary in order to assure the Nation an adequate supply of milk free of contamination by radioactive fallout, he may make feed owned or controlled by the Commodity Credit Corporation available to producers of milk in any area or areas of the United States at such prices and on such terms and conditions as he deems appropriate in the public interest.[11] (7 U.S.C. 1427.)

SALE OF STOCKPILE COTTON

JOINT RESOLUTION OF JULY 10, 1957

Relating to the stockpile of extra long staple cotton under the Strategic and Critical Materials Stockpiling Act.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That notwithstanding any other provision of law, fifty thousand bales of domestically grown extra long staple cotton in the stockpile (including any cotton which does not meet current stockpile specifications) established pursuant to the Strategic and Critical Materials Stockpiling Act, as amended (50 U.S.C. 98), shall be withdrawn and transferred to the Commodity Credit Corporation for sale at not less than the prices at which the Commodity Credit Corporation may sell its stocks under the minimum pricing provision of section 407 of the Agricultural Act of 1949, as amended. Proceeds from such sale, less costs incurred by Commodity Credit Corporation, including administrative expense, as determined by the Secretary of Agriculture, shall be covered into the Treasury of the United States as miscellaneous receipts. (71 Stat. 290.)

ACT OF JULY 25, 1962

To facilitate the sale and disposal of Government stocks of extra long staple cotton.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, notwithstanding any other provision of law, all extra long staple cotton remaining in the stockpile established pursuant to the Strategic and Critical

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[9] This sentence was added by the Act of July 29, 1954, 68 Stat. 583.
[10] This sentence was added by the Act of January 28, 1956, 70 Stat. 6.
[11] This last sentence was added by sec. 404 of the Food and Agriculture Act of 1962, 76 Stat. 632.

Materials Stock Piling Act, as amended (50 U.S.C. 98), shall be withdrawn and transferred or made available to the Commodity Credit Corporation for disposition as provided herein. The domestically grown cotton in the stockpile shall be transferred to the Commodity Credit Corporation and shall be sold only for unrestricted use at not less than the prices at which the Commodity Credit Corporation may sell its stocks under the minimum pricing provisions of section 407 of the Agricultural Act of 1949, as amended. Such domestically grown cotton shall be excluded in making any determination with respect to national marketing quotas under the Agricultural Adjustment Act of 1938, as amended, until after it is sold by Commodity Credit Corporation. The foreign-grown cotton in the stockpile shall be transferred to the Commodity Credit Corporation. Any foreign-grown cotton transferred hereunder to the Commodity Credit Corporation shall be sold or disposed of only for export at not less than the world market price, as determined by the Secretary of Agriculture. In administering sales or disposals of the foreign-grown cotton, the Secretary of Agriculture shall periodically determine and announce quotas for disposals by commercial sales and for disposals through the Agricultural Trade Development and Assistance Act of 1954, as amended. Such foreign-grown cotton shall be excluded in making any determination with respect to national marketing quotas under the Agricultural Adjustment Act of 1938, as amended, and shall be considered as domestically grown surplus cotton for purposes of sale or disposal under the provisions of the Agricultural Trade Development and Assistance Act of 1954, as amended, and shall be eligible for sale or disposal thereunder in accordance with the provisions of this Act.

Proceeds from such sales and dispositions, less costs incurred by Commodity Credit Corporation, including administrative expense, as determined by the Secretary of Agriculture, shall be covered into the Treasury of the United States as miscellaneous receipts. (76 Stat. 218.)

SUBPART D. BARTER AND EXCHANGE OF SURPLUS COMMODITIES

[See sec. 416 of the Agricultural Act of 1949, as amended, on p. 165.]

Commodity Credit Corporation Charter Act. SEC. 4(h) * * * Notwithstanding any other provision of law, the Commodity Credit Corporation is authorized, upon terms and conditions prescribed or approved by the Secretary of Agriculture, to accept strategic and critical materials produced abroad in exchange for agricultural commodities acquired by the Corporation. Insofar as practicable, in effecting such exchange of goods, normal commercial trade channels shall be utilized and priority shall be given to commodities easily storable and those which serve as prime incentive goods to stimulate production of critical and strategic materials. The determination of the quantities and qualities of such materials which are desirable for stock piling and the determination of which materials are strategic and critical shall be made in the manner prescribed by section 2 of the Strategic and Critical Materials Stock Piling Act (60 Stat. 596). Strategic and critical materials acquired by Commodity Credit Corporation in exchange for agricultural commodities shall, to the extent approved by the Munitions Board of the Department of Defense,[1] be transferred to the stock pile provided for by the Strategic and Critical Materials Stock Piling Act; and when transferred to the stock pile the Commodity Credit Corporation shall be reimbursed for the strategic and critical materials so transferred to the stock pile from the funds made available for the purpose of the Strategic and Critical Materials Stock Piling Act, in an amount equal to the fair market value, as determined by the Secretary of the Treasury,[2] of the material transferred to the stock pile. Nothing contained herein shall limit the authority of the Commodity Credit Corporation to acquire, hold, or dispose of such quantity of strategic and critical materials as it deems advisable in carrying out its functions and protecting its assets. (15 U.S.C. 714b(h).)

Agricultural Trade Development and Assistance Act of 1954, as amended. SEC. 303. The Secretary shall, whenever he determines that such action is in the best interest of the United States, and to the maximum extent practicable, barter or exchange agricultural commodities owned by the Commodity Credit Corporation for (a) such strategic or other materials of which the United States does not domestically produce its requirements and which entail less risk of loss through deterioration or substantially less storage charges as the President may designate, or (b) materials, goods, or equipment required in connection with foreign economic and military aid and as-

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[1] "Department of Defense" substituted for "National Military Establishment" by the Act of August 10, 1949, 63 Stat. 578, 591.

[2] This function was transferred to the Administrator of General Services by sec. 102 of the Act of June 30, 1949, 63 Stat. 380; 5 U.S.C. 630a.

sistance programs, or (c) materials or equipment required in substantial quantities for offshore construction programs. He is hereby directed to use every practicable means, in cooperation with other Government agencies, to arrange and make, through private channels, such barters or exchanges or to utilize the authority conferred on him by section 4(h) of the Commodity Credit Corporation Charter Act, as amended, to make such barters or exchanges. In carrying out barters or exchanges authorized by this section, no restrictions shall be placed on the countries of the free world into which surplus agricultural commodities may be sold, except to the extent that the Secretary shall find necessary in order to take reasonable precautions to safeguard usual marketings of the United States and to assure that barters or exchanges under this Act will not unduly disrupt world prices of agricultural commodities or replace cash sales for dollars. The Secretary may permit the domestic processing of raw materials of foreign origin. The Secretary shall endeavor to cooperate with other exporting countries in preserving normal patterns of commercial trade with respect to commodities covered by formal multilateral international marketing agreements to which the United States is a party. Agencies of the United States Government procuring such materials, goods, or equipment are hereby directed to cooperate with the Secretary in the disposal of surplus agricultural commodities by means of barter or exchange. The Secretary is also directed to assist, through such means as are available to him, farmers' cooperatives in effecting exchange of agricultural commodities in their possession for strategic materials.[3] (68 Stat. 459, July 10, 1954; 72 Stat. 1791, September 6, 1958. 7 U.S.C. 1692.)

Agricultural Act of 1956, as Amended. SEC. 206. (a) Strategic and other materials acquired by the Commodity Credit Corporation as a result of barter or exchange of agricultural commodities or products, unless acquired for the national stockpile established pursuant to the Strategic and Critical Materials Stock Piling Act (50 U.S.C. 98–98h), or for other purposes shall be transferred to the supplemental stockpile established by section 104(b) of the Agricultural Trade Development and Assistance Act of 1954 (7 U.S.C. 1704); but no strategic or critical material shall be acquired by the Commodity Credit Corporation as a result of such barter or exchange, except for such national stockpile, for such supplemental stockpile, for foreign economic or military aid or assistance programs, or for offshore construction programs,[4] or to meet requirements of government agencies.[5]

(b) [This subsection which provided that strategic materials acquired by the Commodity Credit Corporation as a result of barter or exchange of agricultural commodities or products may be entered or withdrawn from warehouse free of duty, was repealed by the Act of May 24, 1962, 76 Stat. 78. The effective date of the repeal was provided for in sec. 102 of the same Act. See Executive Order No. 11075, 19 U.S.C.A. 1801 note.]

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[3] See sec. 304(b) of the Agricultural Trade Development and Assistance Act of 1954 with respect to the limitation on use of this authority for Communist-controlled areas.

[4] The material following the semicolon was added by the Act of September 6, 1958, 72 Stat. 1791.

[5] This phrase was added by the Act of September 21, 1959, 73 Stat. 611.

(c) In order to reimburse the Commodity Credit Corporation for materials transferred to the supplemental stockpile there are hereby authorized to be appropriated amounts equal to the value of any materials so transferred. The value of any such material for the purpose of this subsection, shall be the lower of the domestic market price or the Commodity Credit Corporation's investment therein as of the date of such transfer, as determined by the Secretary of Agriculture. (70 Stat. 200, May 28, 1956. 7 U.S.C. 1856.)

ACT OF AUGUST 11, 1939

To facilitate the execution of arrangements for the exchange of surplus agricultural commodities produced in the United States for reserve stocks of strategic and critical materials produced abroad.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, notwithstanding any other provision of law, whenever the President, by and with the advice and consent of the Senate, has concluded a treaty involving the exchange of surplus agricultural commodities produced in the United States which are held under loans made or made available by the Commodity Credit Corporation for stocks of strategic and critical materials produced abroad, the Commodity Credit Corporation is authorized, upon terms and conditions prescribed by the Secretary of Agriculture, to accept such strategic and critical materials in exchange for such surplus agricultural commodities; and for the purpose of such exchange the Secretary of War,[6] the Secretary of the Navy, and the Secretary of the Interior acting jointly through the agency of the Army and Navy Munitions Board,[7] shall determine which materials are strategic and critical and the quantity and quality of such materials. In order to carry out the provisions of this Act, the Commodity Credit Corporation is authorized, upon terms and conditions prescribed by the Secretary of Agriculture, to procure, convey, transport, handle, store, maintain, or rotate such surplus agricultural commodities, and such reserve stocks of strategic and critical materials, as may be necessary to accomplish the purposes of this Act.

The Commodity Credit Corporation is authorized and directed to transfer to warehouses in or near cotton manufacturing centers in New England not to exceed three hundred thousand bales of cotton, to which it now has title or may hereafter acquire title, having regard for the grades and staples customarily required by manufacturers in that area: *Provided*, That all necessary costs in connection with such transfer will not result in additional net cost to the Corporation.

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[6] The Department of War was designated the Department of the Army and the title of the Secretary of War was changed to Secretary of the Army by section 205(a) of act July 26, 1947, ch. 343, title II, 61 Stat. 501. Section 205(a) of act July 26, 1947, was repealed by section 53 of act Aug. 10, 1956, ch. 1041, 70A, Stat. 641. Section 1 of act Aug. 10, 1956, enacted "Title 10, Armed Forces" which in sections 3011–3013 continued the military Department of the Army under the administrative supervision of a Secretary of the Army.

[7] The Army and Navy Munitions Board ceased to exist when the Chairman of the Board of Munitions took office and the records and personnel of the Army and Navy Munitions Board were transferred to the Munitions Board by act July 26, 1947, ch. 343, title II, sec. 213, 61 Stat. 505.

The Munitions Board was abolished by section 2 of 1953 Reorg. Plan No. 6, 18 F.R. 3743, 67 Stat. 638, and all functions of the Munitions Board were transferred to the Secretary of Defense by section 1 of 1953 Reorg. Plan.

In determining specific cotton to be exchanged under this Act, the determination shall be made by sampling and selection at the place where the cotton is stored on the date of ratification of a treaty providing for such exchange, and no cotton shall be exchanged under such treaty which, after such date, is transported to another place and there sampled and selected. Such reserve stocks of strategic and critical materials shall be stored on military or naval reservations or in other locations approved by the Secretary of War and the Secretary of the Navy. The Commodity Credit Corporation is authorized to transfer such reserve stocks of strategic and critical materials, upon such terms and conditions as the Secretary of Agriculture shall approve, to any other governmental agency. Such reserve stocks or strategic and critical materials shall be made available or disposed of by the Commodity Credit Corporation or other governmental agency only upon order of the President in accordance with the terms of the applicable treaty; when necessary to prevent deterioration, the Commodity Credit Corporation or other governmental agency is authorized to replace those quantities of the reserve stocks of such strategic and critical materials subject to deterioration with equivalent quantities of the same materials. The funds now or hereafter made available to the Commodity Credit Corporation are hereby made available to carry out the purposes of this Act. There is hereby authorized to be appropriated such additional sums as may be required to carry out the provisions of this Act. All funds for carrying out the provisions of this Act shall be available for allotment to bureaus and offices of the Department of Agriculture, and for transfer to such other agencies of the Federal Government as the Secretary of Agriculture may request to cooperate or assist in carrying out the provisions of this Act. (53 Stat. 1407, 15 U.S.C. 713 a–7.)

SUBPART E—EXPORT AND SURPLUS REMOVAL

[See also the following statutory provisions:

	Page
Section 2 of the Agricultural Act of 1961 (declaration of policy)	327
Section 4(h) of the Commodity Credit Corporation Charter Act (barter of agricultural commodities for strategic and critical materials produced abroad)	136
Section 407 of the Agricultural Act of 1949 (exempting export sales from certain pricing restrictions and making farm commodities available to relieve distress)	160
Section 416 of the Agricultural Act of 1949 (disposition of surplus commodities)	165
Title VI of the Agricultural Act of 1954 (acquiring information on foreign demand for United States agricultural commodities)]	329

AGRICULTURAL ACT OF 1956[1]

AN ACT

To enact the Agricultural Act of 1956.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Agricultural Act of 1956".

TITLE I—SOIL BANK ACT

[The provisions of this title are to be found beginning on p. 117.]

TITLE II—SURPLUS DISPOSAL

PROGRAM OF ORDERLY LIQUIDATION

SEC. 201. (a) The Commodity Credit Corporation shall, as rapidly as possible consistent with its existing authority, the operation of the price support program, and orderly liquidation, dispose of all stocks of agricultural commodities held by it.

(b) The Secretary shall submit to Congress within ninety days after the enactment of this Act detailed programs, with recommendations for any additional legislation needed to carry out such programs, (1) for the disposition of surplus commodities as required by subsection (a) above; (2) for a food stamp plan or similar program for distribution through States (including the District of Columbia, the Territories, Puerto Rico and the Virgin Islands) and local units of Government of future surplus production to needy persons in the United States, its Territories, and possessions, so as to prevent the accumulation of commodities in the hands of the Commodity Credit Corporation; and (3) for strategic stockpiling of foodstuffs and other agricultural products (A) inside the United States and (B) outside the United States as authorized in section 415 of the Mutual

[1] Approved May 28, 1956, 70 Stat. 188.

Security Act of 1954. The Secretary shall report annually on his operations under subsection (a) and such reports shall show—

(1) the quantities of surplus commodities on hand;

(2) the methods of disposition utilized and the quantities disposed of during the preceding twelve months;

(3) the methods of disposition to be utilized and the estimated quantities that can be disposed of during the succeeding twelve months;

(4) a detailed program for the expansion of markets for surplus agricultural commodities through marketing and utilization research and improvement of marketing facilities; and

(5) recommendations for additional legislation necessary to accomplish the purposes of this section. (7 U.S.C. 1851.)

EXTRA-LONG STAPLE COTTON

SEC. 202. (a) Hereafter the quota for cotton having a staple length of one and one-eighth inches or more, established September 20, 1939, pursuant to section 22 of the Agricultural Adjustment Act of 1933, as amended, shall apply to the same grades and staple lengths included in the quota when such quota was initially established. Such quota shall provide for cotton having a staple length of one and eleven-sixteenths inches and longer, and shall establish dates for the quota year which will recognize and permit entry to conform to normal marketing practices and requirements for such cotton.

(b) Beginning not later than August 1, 1956, the Commodity Credit Corporation is directed to sell for export at competitive world prices its stocks of domestically produced extra long staple cotton on hand on the date of enactment of this Act. The amount offered and the price accepted by the Commodity Credit Corporation shall be such as to dispose of such quantity in an orderly manner and within a reasonable period of time. (7 U.S.C. 1852.)

EXPORT SALES PROGRAM FOR COTTON

SEC. 203. In furtherance of the current policy of the Commodity Credit Corporation of offering surplus agricultural commodities for sale for export at competitive world prices, the Commodity Credit Corporation is directed to use its existing powers and authorities immediately upon the enactment of this Act to encourage the export of cotton by offering to make cotton available at prices not in excess of the level of prices at which cottons of comparable qualities are being offered in substantial quantity by other exporting countries and, in any event, for the cotton marketing year beginning August 1, 1956, at prices not in excess of the minimum prices (plus carrying charges, beginning October 1, 1956, as established pursuant to Section 407 of the Agricultural Act of 1949) at which cottons of comparable qualities were sold under the export program announced by the United States Department of Agriculture on August 12, 1955. The Commodity Credit Corporation may accept bids in excess of the maximum prices specified herein but shall not reject bids at such maximum prices unless a higher bid is received for the same cotton. Cottons of qualities not comparable to those of cottons sold under

the program announced on August 12, 1955, shall be offered at prices not in excess of the maximum prices prescribed hereunder for cottons of qualities comparable to those of cottons sold under such program, with appropriate adjustment for differences in quality. Such quantities of cotton shall be sold as will reestablish and maintain the fair historical share of the world market for United States cotton, said volume to be determined by the Secretary of Agriculture. (7 U.S.C. 1853.)

COTTON EXPORT PROGRAM

[Agricultural Act of 1958—Sec. 110. Nothing in this Act shall be construed to affect or modify the provisions of section 203 of the Agricultural Act of 1956, and any cotton owned or acquired by the Commodity Credit Corporation under any price support program may be used for the purpose of carrying out the cotton export program provided for in section 203 of the Agricultural Act of 1956. (72 Stat. 993, 7 U.S.C. 1853 note.)]

[Public Law 88–638—Sec. 3. Notwithstanding any other provision of law, the Commodity Credit Corporation, in order to encourage exports of extra long staple cotton which is in surplus supply at competitive world prices, is directed to offer for sale, whenever extra long staple cotton is in surplus supply, any extra long staple cotton owned by it (except stocks released from the stockpile established pursuant to the Strategic and Critical Materials Stock Piling Act, as amended) at prices not in excess of the prices at which cotton of comparable quality is being offered by other exporting countries, on condition that such cotton be exported or that an equal quantity of extra long staple cotton will be exported within the period specified by the Secretary of Agriculture. The Commodity Credit Corporation may accept bids in excess of the maximum prices specified herein but shall not reject bids at such maximum prices unless a higher bid is received for the same cotton. The Secretary of Agriculture shall make a determination of the amount, if any, of extra long staple cotton which is in surplus supply for the 1964–65 marketing year not later than thirty days after the effective date of this section and for each succeeding marketing year not later than thirty days prior to the beginning of each such marketing year. Extra long staple cotton shall be deemed to be in surplus supply whenever the Secretary of Agriculture determines that the total supply of such cotton (under the formula for determining the "Total supply" of cotton specified in Section 301(b)(16)(C) of the Agricultural Adjustment Act of 1938, as amended, but not including cotton released from such stockpile) is in excess of estimated domestic consumption and estimated exports of such cotton excluding estimated exports made under the authority of this section, plus an allowance for carryover equal to fifty per centum of such estimated consumption and exports. Exports hereunder shall be excluded in making any determination with respect to national marketing quotas under the Agricultural Adjustment Act of 1938, as amended. Nothing herein shall preclude the Corporation from accepting bids which may be made at higher than world prices. (78 Stat. 1038, approved October 8, 1964.)]

[ACT OF JULY 25, 1962

AN ACT

To facilitate the sale and disposal of Government stocks of extra long staple cotton.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, notwithstanding any other provision of law, all extra long staple cotton remaining in the stockpile established pursuant to the Strategic and Critical Materials Stock Piling Act, as amended (50 U.S.C. 98), shall be withdrawn and transferred or made available to the Commodity Credit Corporation for disposition as provided herein. The domestically grown cotton in the stockpile shall be transferred to the Commodity Credit Corporation and shall be sold only for unrestricted use at not less than the prices at which the Commodity Credit Corporation may sell its stocks under the minimum pricing provisions of section 407 of the Agricultural Act of 1949, as amended. Such domestically grown cotton shall be excluded in making any determination with respect to national marketing quotas under the Agricultural Adjustment Act of 1938, as amended, until after it is sold by Commodity Credit Corporation. The foreign-grown cotton in the stockpile shall be transferred to the Commodity Credit Corporation. Any foreign-grown cotton transferred hereunder to the Commodity Credit Corporation shall be sold or disposed of only for export at not less than the world market price, as determined by the Secretary of Agriculture. In administering sales or disposals of the foreign-grown cotton, the Secretary of Agriculture shall periodically determine and announce quotas for disposals by commercial sales and for disposals through the Agricultural Trade Development and Assistance Act of 1954, as amended. Such foreign-grown cotton shall be excluded in making any determination with respect to national marketing quotas under the Agricultural Adjustment Act of 1938, as amended, and shall be considered as domestically grown surplus cotton for purposes of sale or disposal under the provisions of the Agricultural Trade Development and Assistance Act of 1954, as amended, and shall be eligible for sale or disposal thereunder in accordance with the provisions of this Act.

Proceeds from such sales and dispositions, less costs incurred by Commodity Credit Corporation, including administrative expense, as determined by the Secretary of Agriculture, shall be covered into the Treasury of the United States as miscellaneous receipts. (76 Stat. 218.)]

AGREEMENTS LIMITING IMPORTS

SEC. 204. [This section appears on p. 284.]

APPROPRIATION TO SUPPLEMENT SECTION 32 FUNDS

SEC. 205. [This section is set out in full on p. 211 in the section entitled "Section 32 and Related Statutes."]

SEC. 206. [This section provides for the transfer of bartered materials to the supplemental stockpile. (See p. 180.)]

SURPLUS DISPOSAL ADMINISTRATOR

SEC. 207.[2] The Secretary of Agriculture is authorized to appoint an agricultural surplus disposal administrator whose duties shall include such responsibility for activities of the Department, including those of the Commodity Credit Corporation, relating to the disposal of surplus agricultural commodities as the Secretary may direct. (7 U.S.C. 1857.)

PAYMENT OF OCEAN FREIGHT

SEC. 208. [This section contains amendments to the Agricultural Trade Development and Assistance Act of 1954, which are incorporated in that Act as contained in this compilation. (See p. 205.)]

COMMISSION TO RECOMMEND LEGISLATION PROVIDING FOR INCREASED INDUSTRIAL USE OF AGRICULTURAL PRODUCTS

SEC. 209. [This section is omitted because the Commission's recommendation was submitted to Congress in 1957.]

DONATION TO PENAL AND CORRECTIONAL INSTITUTIONS

SEC. 210. [This section appears on p. 221 in the section entitled "Donations."]

FEDERAL IRRIGATION, DRAINAGE, AND FLOOD-CONTROL PROJECTS

SEC. 211. [This section expired May 28, 1959. See p. 159 of Agriculture Handbook No. 192 for text.]

SEC. 212. [This section amended section 416 of the Agricultural Act of 1949.]

TITLE III—MARKETING QUOTAS AND ACREAGE ALLOTMENTS

[This title contains amendments to the Agricultural Adjustment Act of 1938, which are incorporated in that act as contained in this compilation.]

TITLE IV—FORESTRY PROVISIONS

[This title contains provisions relating to assistance to states for tree planting and reforestation.]

TITLE V—CERTIFICATE PROGRAM FOR RICE

[This title added subtitle D—Rice Certificates to title III of the Agricultural Adjustment Act of 1938 and appears on p. 110.]

TITLE VI—MISCELLANEOUS

[This title contains amendments to the Agricultural Act of 1949 and the Agricultural Adjustment Act of 1938, which are incorporated in those acts as contained in this compilation.]

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[2] Amended by Pub. L. 87–793, October 11, 1962, 76 Stat. 849.

INTERNATIONAL WHEAT AGREEMENT ACT OF 1949,[1] AS AMENDED

AN ACT

To give effect to the International Wheat Agreement signed by the United States and other countries relating to the stabilization of supplies and prices in the international wheat market.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act shall be known as the "International Wheat Agreement Act of 1949." (7 U.S.C. 1641 note.)

SEC. 2. The President is hereby authorized, acting through the Commodity Credit Corporation, to make available or cause to be made available, notwithstanding the provisions of any other law, such quantities of wheat and wheat-flour and at such prices as are necessary to exercise the rights, obtain the benefits, and fulfill the obligations of the United States [2] under the International Wheat Agreement of 1949 signed by Australia, Canada, France, the United States, Uruguay, and certain wheat importing countries, along with the agreements signed by the United States and certain other countries revising and renewing such agreement of 1949 for periods through July 31, 1965 (hereinafter collectively called the "International Wheat Agreement"). Nothing herein shall be construed to preclude the Secretary of Agriculture, in carrying out programs to encourage the exportation of agricultural commodities and products thereof pursuant to section 32 of Public Law 320, Seventy-fourth Congress, as amended, from utilizing funds available for such programs in such manner as, either separately or jointly with the Commodity Credit Corporation, to exercise the rights, obtain the benefits, and fulfill all or any part of the obligations of the United States under the International Wheat Agreement or to preclude the Commodity Credit Corporation in otherwise carrying out wheat and wheat-flour export programs as authorized by law. Nothing contained herein shall limit the duty of the Commodity Credit Corporation to the maximum extent practicable consistent with the fulfillment of the Corporation's purposes and the effective and efficient conduct of its business to utilize the usual and customary channels, facilities, and arrangements of trade and commerce in making available or causing to be made available wheat and wheat-flour hereunder. The pricing provisions of section 112(e) of the Economic Cooperation Act of 1948 and section 4 of the Act of July 16, 1943 (57 Stat. 566), shall not be applicable to domestic wheat

[1] Approved October 27, 1949, 63 Stat. 945. The original International Wheat Agreement was a contractual agreement between the governments of 4 wheat-exporting countries and 42 wheat-importing countries for the period August 1, 1949, to August 1, 1953. The International Wheat Agreement Act of 1949 was implementing legislation authorizing the necessary action to carry out the terms of this agreement. The agreement has been renegotiated at three-year intervals since 1953. It has been ratified by 10 exporting and 38 importing countries as of October 31, 1964.

[2] The rest of this sentence was substituted for the previous language by the Act of September 21, 1959 (73 Stat. 600) and the Act of September 5, 1962 (76 Stat. 434).

758-820—65——14

and wheat-flour supplied to countries which are parties to the International Wheat Agreement and credited to their guaranteed purchases thereunder on and after August 1, 1949, and up to and including June 30, 1950.[3] Where prices in excess of the International Wheat Agreement prices have been paid for such wheat and wheat-flour financed by the Economic Cooperation Administration on or after August 1, 1949, and up to and including June 30, 1950, the Secretary of Agriculture or Commodity Credit Corporation is authorized to reimburse the Economic Cooperation Administration for such excess amounts. Funds realized from such reimbursement shall revert to the respective appropriation or appropriations from which funds were expended for the procurement of such wheat and wheat-flour. There are hereby authorized to be appropriated such sums as may be necessary to make payments to the Commodity Credit Corporation of its estimated or actual net costs of carrying out its functions hereunder.[4] Such net costs in connection with the International Wheat Agreement, 1959, shall include those with respect to all transactions which qualify as commercial purchases (as defined in such agreement) from the United States by importing member countries.[5] Such net costs in connection with the International Wheat Agreement, 1962, shall include those with respect to all transactions which qualify as commercial purchases (as defined in such agreement) from the United States by member and provisional member importing countries, including transactions entered into prior to the deposit of instruments of acceptance or accession by any of the countries involved, if the loading period is not earlier than the date the agreement enters into force.[6] The Commodity Credit Corporation is hereby authorized in carrying out its functions hereunder to utilize, in advance of such appropriations or payments, any assets available to it. (7 U.S.C. 1641.)

SEC. 3. (a) The President is hereby further authorized to take such other action, including prohibiting or restricting the importation or exportation of wheat or wheat-flour and to issue such rules or regulations which shall have the force and effect of law, as may be necessary in his judgment in the implementation of the International Wheat Agreement. (7 U.S.C. 1642(a).)

(b) All persons exporting or importing wheat or wheat-flour or selling wheat or wheat-flour for export shall report to the President such information as he may from time to time require and keep such records as he finds to be necessary to enable him to carry out the purposes of this Act. Such information shall be reported and such records shall be kept in accordance with such regulations as the President may prescribe. For the purposes of ascertaining the correctness of any report made or record kept, or of obtaining information required to be furnished in any report, but not so furnished, the

[3] Sec. 112(m) of the Economic Cooperation Act of 1948 (as added by the Act of June 5, 1950, 64 Stat. 198, 200; 22 U.S.C. 1510(m)) provides:

"(m) Notwithstanding any other provision of law, the pricing provisions of section 112(c) of this title and section 4 of the Act of July 16, 1943 (57 Stat. 566) shall not be applicable to domestic wheat and wheat flour procured under this title or any other Act providing for assistance or relief to foreign countries, supplied to countries which are parties to the International Wheat Agreement of 1949 and credited to their guaranteed purchases thereunder."

[4] Several appropriations have been made pursuant to this provision.

[5] The preceding sentence was added by the Act of September 21, 1959, 73 Stat. 600.

[6] Sentence added by the Act of September 5, 1962 (P.L. 87-632, 76 Stat. 434).

President is hereby authorized to examine such books, papers, records, accounts, correspondence, contracts, documents, and memoranda as are relevant to transactions under the International Wheat Agreement and are within the control of any such person. (7 U.S.C. 1642(b).)

(c) Any person failing to make any report or keep any record as required by or pursuant to this section 3, or making any false report or record or knowingly violating any rule or regulation of the President issued pursuant to this section 3 shall be deemed guilty of a misdemeanor and upon conviction thereof shall be subject to a fine of not more than $1,000 for each violation. (7 U.S.C. 1642(c).)

(d) Any person who knowingly and wilfully exports wheat or wheat-flour from the United States, or who knowingly and willfully imports wheat or wheat-flour into the United States for consumption therein, in excess of the quantity of wheat or wheat-flour permitted to be exported or imported, as the case may be, under regulations issued by the President shall forfeit to the United States a sum equal to two times the market value at the time of the commission of any such act, of the quantity of wheat or wheat-flour by which any such exportation or importation exceeds the authorized amount which forfeiture shall be recoverable in a civil suit brought in the name of the United States. (7 U.S.C. 1642(d).)

(e) The district courts of the United States and the District Court of the United States for the District of Columbia shall have jurisdiction of violations of this Act or the rules and regulations thereunder, and of all suits in equity and actions at law brought to enforce any liability or duty created by this Act or the rules and regulations thereunder. Any criminal proceeding may be brought in the district wherein any act or transaction constituting the violation occurred. Any suit or action to enforce any liability or duty created by this Act or rules and regulations thereunder, or to enjoin any violation of such Act or rules and regulations, may be brought in any such district wherein the defendant is found or is a resident or transacts business. The remedies, fines, and forfeitures provided for in this Act shall be in addition to, and not exclusive of, any of the remedies, fines, and forfeitures under existing law. (7 U.S.C. 1642(e).)

(f) Any power, authority, or discretion conferred on the President by this Act may be exercised through such department, agency, or officer of the Government as the President may direct, and shall be exercised in conformity with such rules or regulations as he may prescribe. (7 U.S.C. 1642(f).)

(g) There are hereby authorized to be appropriated such sums as may be necessary to carry out the provisions of this section, including the necessary expenses and contributions of the United States in connection with the administration of the International Wheat Agreement. (7 U.S.C. 1642(g).)

(h) Funds appropiated under authority of this Act may be used for the purchase or hire of passenger motor vehicles, for printing and binding, for rent and personal services in the District of Columbia and elsewhere without regard to the limitation contained in section 607(g) of the Federal Employees Pay Act of 1945, as amended,[7] and

[7] Sec. 607(g) was repealed September 12, 1950, 64 Stat. 843.

for the employment of experts or consultants or organization thereof, on a temporary basis, by contract or otherwise, without regard to the Classification Act, at rates not in excess of $50 per diem. (7 U.S.C. 1642(h).)

(i) The functions exercised under authority of this Act shall be excluded from the operation of the Administrative Procedure Act (60 Stat. 237) except as to the requirements of sections 3 and 10 thereof. (7 U.S.C. 1642(i).)

(j) The term "person" as used in this section shall include the singular and the plural and any individual, partnership, corporation, association, as any other organized group of persons. (7 U.S.C. 1642(j).)

[Act of August 1, 1953—Sec. 2. Reference in any law to the International Wheat Agreement of 1949 shall be deemed to include the agreement revising and renewing the International Wheat Agreement. (67 Stat. 358; 7 U.S.C. 1641 note.)]

[Act of August 3, 1956—Sec. 2. Reference in any law to the International Wheat Agreement of 1949 shall be deemed to include the Agreement (International Wheat Agreement, 1956) revising and renewing the International Wheat Agreement for a period ending July 31, 1959. (70 Stat. 966; 7 U.S.C. 1641 note.)]

SALE TO FOREIGN GOVERNMENTS

Joint Resolution of August 11, 1939.—That notwithstanding any other provision of law, the Commodity Credit Corporation, with the approval of the President, is authorized to sell surplus agricultural commodities, acquired by such Corporation through its loan operations, to foreign governments on the condition that, except for rotation to prevent deterioration, such commodities shall be held in reserve by such governments for a period of not less than five years from the date of acquisition, and shall not be disposed of unless a war or war emergency results in a serious interruption of normal supplies of such commodities: *Provided*, That under this joint resolution no concession below the prevailing world market price for the unrestricted use of such commodities, as determined by the Secretary of Agriculture, shall be granted, in consideration of the obligation assumed by such governments to hold such commodities in reserve as required hereinbefore, in excess of a maximum amount equal to the average carrying charges, as estimated by the Secretary of Agriculture, that would be incurred if such commodities should be held for an additional eighteen months' period by the Commodity Credit Corporation. In determining specific cotton to be sold under this Act, the determination shall be made by sampling and selection at the place where the cotton is stored on the date of signing any sales agreement or contract under this Act, and no cotton shall be sold under any such sales agreement or contract which, after such date, is transported to any other place and there sampled and selected: *Provided further*, That in case of a sale settlement must be made within sixty days after delivery and not more than five hundred thousand bales of cotton shall be sold upon the terms and conditions provided in this joint resolution. (Pub. Res. 52, 76th Con., 53 Stat. 1418; 15 U.S.C. 713a–6.)

AGRICULTURAL TRADE DEVELOPMENT AND ASSISTANCE ACT OF 1954,[1] AS AMENDED

Public Law 480—83d Congress

AN ACT

To increase the consumption of United States agricultural commodities in foreign countries, to improve the foreign relations of the United States, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Agricultural Trade Development and Assistance Act of 1954".

SEC. 2. It is hereby declared to be the policy of Congress to expand international trade among the United States and friendly nations, to facilitate the convertibility of currency, to promote the economic stability of American agriculture and the national welfare, to make maximum efficient use of surplus agricultural commodities in furtherance of the foreign policy of the United States, and to stimulate and facilitate the expansion of foreign trade in agricultural commodities produced in the United States by providing a means whereby surplus agricultural commodities in excess of the usual marketings of such commodities may be sold through private trade channels, and foreign currencies accepted in payment therefor. It is further the policy to use foreign currencies which accrue to the United States under this Act to expand international trade, to encourage economic development, to purchase strategic materials, to pay United States obligations abroad, to promote collective strength,

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[1] Approved July 10, 1954, 68 Stat. 454. See also sec. 402 of the Mutual Security Act of 1954, as amended (22 U.S.C. 1922), which provides:

"SEC. 402. EARMARKING OF FUNDS.—Of the funds authorized to be made available in the fiscal year 1961 pursuant to this Act (other than funds made available pursuant to title II), not less than $175,000,000 shall be used to finance the export and sale for foreign currencies or the grant of surplus agricultural commodities or products thereof produced in the United States, in addition to surplus agricultural commodities or products transferred pursuant to the Agricultural Trade Development and Assistance Act of 1954, and in accordance with the standards as to pricing and the use of private trade channels, expressed in section 101 of said Act. Foreign currency proceeds accruing from such sales shall be used for the purposes of this Act and with particular emphasis on the purposes of section 104 of the Agricultural Trade Development and Assistance Act of 1954 which are in harmony with the purposes of this Act. Notwithstanding section 1415 of the Supplemental Appropriation Act, 1953, or any other provision of law, the President may use or enter into agreements with friendly nations or organizations of nations to use for such purposes the foreign currencies which accrue to the United States under this section. Surplus food commodities or products thereof made available for transfer under this Act (or any other Act) as a grant or as a sale for foreign currencies may also be made available to the maximum extent practicable to eligible domestic recipients pursuant to section 416 of the Agricultural Act of 1949, as amended (7 U.S.C. 1431), or to needy persons within the United States pursuant to clause (2) of section 32 of the Act of August 24, 1935, as amended (7 U.S.C. 612c)."

and to foster in other ways the foreign policy of the United States.[2] (7 U.S.C. 1691.)

TITLE I—SALES FOR FOREIGN CURRENCY[3]

SEC. 101. In furtherance of this policy, the President is authorized to negotiate and carry out agreements with friendly nations or organizations of friendly nations to provide for the sale of surplus agricultural commodities for foreign currencies. In negotiating such agreements the President shall—

(a) take reasonable precautions to safeguard usual marketings of the United States and to assure that sales under this Act will not unduly disrupt world prices of agricultural commodities or normal patterns of commercial trade with friendly countries;[4]

(b) take appropriate steps to assure that private trade channels are used to the maximum extent practicable both with respect to sales from privately owned stocks and from stocks owned by the Commodity Credit Corporation;

(c) give special consideration to utilizing the authority and funds provided by this Act, in order to develop and expand continuous market demand abroad for agricultural commodities, with appropriate emphasis on underdeveloped and new market areas;

(d) seek and secure commitments from participating countries that will prevent resale or transshipment to other countries, or

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[2] Subsection (f) of sec. 2 of the Mutual Security Act of 1954, as amended (22 U.S.C. 1750), provides as follows:

"(f) It is the sense of the Congress that inasmuch as—

(1) the United States favors freedom of navigation in international waterways and economic cooperation between nations; and

(2) the purposes of this Act are negated and the peace of the world is endangered when nations which receive assistance under this Act wage economic warfare against other nations assisted under this Act, including such procedures as boycotts, blockades, and the restriction of the use of international waterways;

assistance under this Act and the Agricultural Trade Development and Assistance Act of 1954, as amended, shall be administered to give effect to these principles, and, in all negotiations between the United States and any foreign state arising as a result of funds appropriated under this Act or arising under the Agricultural Trade Development and Assistance Act of 1954, as amended, these principles shall be applied, as the President may determine, and he shall report on measures taken by the Administration to insure their application."

[3] Sec. 603 of the International Development Act of 1961 provides: "SHIPPING ON UNITED STATES VESSELS.—The ocean transportation between foreign countries of commodities and defense articles purchased with foreign currencies made available or derived from funds made available under this Act or the Agricultural Trade Development and Assistance Act of 1954, as amended (7 U.S.C. 1691 et seq.), and transfers of fresh fruit and products thereof under this Act, shall not be governed by the provisions of section 901(b) of the Merchant Marine Act of 1936, as amended (46 U.S.C. 1241), or any other law relating to the ocean transportation of commodities on United States flag vessels." 75 Stat. 439, September 4, 1961. Sec. 504 of the Mutual Security Act of 1954, as amended (22 U.S.C. 1761) contains similar language.

See also Sec. 3 of the Act of August 3, 1956, 70 Stat. 988, which provides that sales of fresh fruit and the products thereof under Title I shall be exempt from the requirements of the cargo preference laws.

Sec. 620 of the Foreign Assistance Act of 1961, 75 Stat. 444, was amended by the Foreign Assistance Act of 1963, 77 Stat. 387, to include subsec. (i) which provided as follows:

"(i) No assistance shall be provided under this or any other Act, and no sales shall be made under the Agricultural Trade Development and Assistance Act of 1954, to any country which the President determines is engaging in or preparing for aggressive military efforts directed against—

(1) the United States,

(2) any country receiving assistance under this or any other Act, or

(3) any country to which sales are made under the Agricultural Trade Development and Assistance Act of 1954,

until the President determines that such military efforts or preparations have ceased and he reports to the Congress that he has received assurances satisfactory to him that such military efforts or preparations will not be renewed. This restriction may not be waived pursuant to any authority contained in this Act."

[4] Phrase beginning with "or" added by the Act of September 6, 1958, 72 Stat. 1790.

use for other than domestic purposes, of surplus agricultural commodities purchased under this Act, without specific approval of the President; and

(e) afford any friendly nation the maximum opportunity to purchase surplus agricultural commodities from the United States, taking into consideration the opportunities to achieve the declared policy of this Act and to make effective use of the foreign currencies received to carry out the purposes of this Act.

(f) [5] obtain rates of exchange applicable to the sale of commodities under such agreements which are not less favorable than the highest of exchange rates legally obtainable in the respective countries, and which are not less favorable than the highest of exchange rates obtainable by any other nation.

(g) [6] require such foreign currencies to be convertible to dollars to the extent consistent with the effectuation of the purpose of this Act, but in any event to the extent necessary to permit that portion of such currencies made available for payment of United States obligations to be used to meet obligations or charges payable by the United States or any of its agencies to the government of the importing country or any of its agencies. (7 U.S.C. 1701.)

SEC. 102.[7] (a) For the purpose of carrying out agreements concluded by the President hereunder, the Commodity Credit Corporation, in accordance with regulations issued by the President pursuant to subsection (b) of this section, (1) shall make available for sale hereunder to domestic exporters surplus agricultural commodities heretofore or hereafter acquired by the Corporation in the administration of its price-support operations, and (2) shall make funds available to finance the sale and exportation of surplus agricultural commodities, whether from private stocks or from stocks of the Commodity Credit Corporation. In supplying such commodities to exporters under this subsection the Commodity Credit Corporation shall not be subject to the sales price restrictions in section 407 of the Agricultural Act of 1949, as amended. The commodity set-aside established for any commodity under section 101 of the Agricultural Act of 1954 (68 Stat. 897) shall be reduced by a quantity equal to the quantity of such commodity financed hereunder which is exported from private stocks. The Commodity Credit Corporation shall finance ocean freight charges incurred pursuant to agreements entered into after December 31, 1964, only to the extent that such

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[5] Subsec. (f) was added by sec. 201 of the Agricultural Act of 1961, 75 Stat. 306, August 8, 1961, and was amended by Pub. L. 88–205, 75 Stat. 391, approved December 16, 1963, and by Pub. L. 88–638, 78 Stat. 1035, approved October 8, 1964.

[6] Subsec. (g) was added by Pub. L. 88–638, 78 Stat. 1035, approved October 8, 1964.

[7] The last two sentences of sec. 102(a) were added by Pub. L. 88–638, 78 Stat. 1035, approved October 8, 1964. Sec. 102(a) was previously amended by the Act of April 25, 1955, 69 Stat. 44.

Sec. 8 of the Act of September 6, 1958, 72 Stat. 1792, 7 U.S.C. 1701 note), provides as follows:

"In carrying out the provisions of the Agricultural Trade Development and Assistance Act of 1954, as amended, extra long staple cotton shall be made available for sale pursuant to the provisions of title I of the Act in the same manner as upland cotton or any other surplus agricultural commodity is made available, and products manufactured from upland or long staple cotton shall be made available for sale pursuant to the provisions of title I of the Act as long as cotton is in surplus supply, and no discriminatory or other conditions shall be imposed which will prevent or tend to interfere with their sale or availability for sale under the Act: Provided, That that portion of the sales price of such products which is financed as a sale for foreign currency under title I of the Act shall be limited to the estimated portion of the sales price of such products attributable to the raw cotton content of such products."

charges are higher (than would otherwise be the case) by reason of a requirement that the commodities be transported in United States flag vessels. Such agreements shall require the balance of such charges for transportation in United States vessels to be paid in dollars by the nations or organizations with whom such agreements are entered into. (7 U.S.C. 1702(a).)

(b) In order to facilitate and maximize the use of private channels of trade in carrying out agreements entered into pursuant to this Act, the President may, under such regulations and subject to such safeguards as he deems appropriate, provide for the issuance of letters of commitment against funds or guaranties of funds supplied by the Commodity Credit Corporation and for this purpose accounts may be established on the books of any department, agency, or establishment of the Government, or on terms and conditions approved by the Secretary of the Treasury in banking institutions in the United States. Such letters of commitment, when issued, shall constitute obligations of the United States and moneys due or to become due thereunder shall be assignable under the Assignment of Claims Act of 1940. Expenditures of funds which have been made available through accounts so established shall be accounted for on standard documentation required for expenditures of Government funds. (7 U.S.C. 1702(b).)

SEC. 103. (a)[8] For the purpose of making payment to the Commodity Credit Corporation to the extent the Commodity Credit Corporation is not reimbursed under section 105 for commodities disposed of and costs incurred under titles I and II of this Act, there are hereby authorized to be appropriated such sums as are equal to (1) the Corporation's investment in commodities made available for export under this title and title II of this Act, including processing, packaging, transportation, and handling costs, (2) all costs incurred by the Corporation in making funds available to finance the exportation of surplus agricultural commodities pursuant to this title and, (3) all Commodity Credit Corporation funds expended for ocean freight costs authorized under title II hereof for purposes of section 416 of the Agricultural Act of 1949, as amended. Any funds or other assets available to the Commodity Credit Corporation may be used in advance of such appropriation or payments, for carrying out the purposes of this Act. In presenting his budget, the President shall classify expenditures under this Act as expenditures for international affairs and finance rather than for agriculture and agricultural resources. (7 U.S.C. 1703(a).)

(b)[9] Agreements shall not be entered into under this title during the period beginning January 1, 1965, and ending December 31, 1966, which will call for appropriations to reimburse the Commodity Credit Corporation in a total amount in excess of $2,700,000,000 plus any amount by which agreements entered into in prior years have called or will call for appropriations to reimburse the Commodity Credit Corporation in amounts less than authorized for such prior years by this Act

[8] The last sentence of subsec. (a) was added by Pub. L. 88–638, 78 Stat. 1035, approved October 8, 1964. Sec. 103(a) was previously amended by sec. 208(a) of the Agricultural Act of 1956, 70 Stat. 201.

[9] Subsec. (b) was amended by Pub. L. 88–638, 78 Stat. 1035, approved October 8, 1964. The amendment is effective January 1, 1965. This subsection has been amended several times.

as in effect during such years: *Provided*, That agreements shall not be entered into during any calendar year of such period which will call for appropriations to reimburse the Commodity Credit Corporation in amounts in excess of $2,500,000,000. (7 U.S.C. 1703(b).)

SEC. 104.[10] Notwithstanding section 1415 of the Supplemental Appropriation Act, 1953, or any other provision of law, the President may use or enter into agreements with friendly nations or organizations of nations to use the foreign currencies, including principal and interest from loan repayments,[11] which accrue under this title for one or more of the following purposes.[12]

(a)[13] To help develop new markets for United States agricultural commodities on a mutually benefiting basis. From sale proceeds and loan repayments under this title not less than the equivalent of 5 per centum of the total sales made each year under this title after the date of this amendment shall be set aside in the amounts and kinds of foreign currencies specified by the Secretary of Agriculture and made available in advance for use as provided by this subsection over such period of years as the Secretary of Agriculture determines will most effectively carry out the purpose of this subsection: *Provided*, That no such funds shall be allocated under this subsection after June 30, 1960, except as may be specified, from time to time, in appropriation acts. Provision shall be made in sale and loan agreements for the convertibility of such amount of the proceeds thereof (not less than 2 per centum) as the Secretary of Agriculture determines to be needed to carry out the purpose of this subsection in those countries which are or offer reasonable potential of becoming dollar markets for United States agricultural commodities. Such sums shall be converted into the types and kinds of foreign currencies as the Secretary deems necessary to carry out the provisions of this subsection and such sums shall be deposited to a special Treasury account and shall not be made available or expended except for carrying out the provisions of this sub-

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[10] Act of August 13, 1957, 71 Stat. 345, provides that within sixty days after any agreement is entered into for the use of any foreign currencies, a full report thereon shall be made to the Senate and House of Representatives of the United States and to the Committees on Agriculture and Appropriations thereof. (7 U.S.C. 1704a.)

[11] The phrase "including principal and interest from loan repayments" was added by the Agricultural Act of 1961, 75 Stat. 306, August 8, 1961.

[12] See sec. 407 of the Act of September 1, 1954, as amended (5 U.S.C. 171z–1), which provides:

"In addition to family housing and community facilities otherwise authorized to be constructed or acquired by the Department of Defense, the Secretary of Defense is authorized, subject to the approval of the Director of the Bureau of the Budget, to construct, or acquire by lease or otherwise, family housing for occupancy as public quarters, and community facilities, in foreign countries through housing and community facilities projects which utilize foreign currencies to a value not to exceed $250,000,000 acquired pursuant to the provisions of the Agricultural Trade Development and Assistance Act of 1954 or through other commodity transactions of the Commodity Credit Corporation.

"The Department of Defense shall pay the Commodity Credit Corporation, from appropriations otherwise available for the payment of quarters allowances for military personnel and from appropriate allotments or rental charges for civilian personnel, amounts equal to the quarters allowances or allotments otherwise payable to or the rental charges collected from personnel occupying any housing constructed or acquired under authority of this section after deducting amounts chargeable for the maintenance and operation of such housing: *Provided*, That such payments shall not exceed the dollar equivalent of the value of the foreign currencies used for all such construction or acquisition."

See also sec. 509 of the Act of June 8, 1960, 74 Stat. 186, which provides:

"SEC. 509. Notwithstanding the provisions of any other law, at least 75 per centum of the total cost of any family housing project or community facility hereafter constructed or acquired in any foreign country by the Department of Defense or any military department shall be paid for from foreign currencies acquired by the Commodity Credit Corporation pursuant to the provisions of the Agricultural Trade Development and Assistance Act of 1954: except that the following projects authorized pursuant to this Act shall not be subject to this requirement: . . ." (list of projects omitted).

[13] Subsec. (a) was amended by the Act of September 21, 1959, 73 Stat. 606, and the Agricultural Act of 1961, 75 Stat. 306, approved August 8, 1961.

section. Notwithstanding any other provision of law, if sufficient foreign currencies for carrying out the purpose of this subsection in such countries are not otherwise available, the Secretary of Agriculture is authorized and directed to enter into agreements with such countries for the sale of surplus agricultural commodities in such amounts as the Secretary of Agriculture determines to be adequate and for the use of the proceeds to carry out the purpose of this subsection;

(b)[14] To purchase or contract to purchase, in such amounts as may be specified from time to time in appropriation acts, strategic or other materials for a supplemental United States stockpile of such materials as the President may determine from time to time. Such strategic or other materials acquired under this subsection shall be placed in the above named supplemental stockpile and shall be released therefrom only under the provisions of section 3 of the Strategic and Critical Materials Stock Piling Act;

(c)[15] To procure equipment, materials, facilities, and services for the common defense including internal security;

(d) For financing the purchase of goods or services for other friendly countries;

(e)[16] For promoting balanced economic development and trade among nations, for which purposes currencies shall also be available to the maximum usable extent through and under the procedures established by such agency as the President shall direct for loans mutually agreeable to said agency and the country with which the agreement is made to United States business firms and branches, subsidiaries, or affiliates of such firms for business development and trade expansion in such countries and for loans to domestic or foreign firms for the establishment of facilities for aiding in the utilization, distribution, or otherwise increasing the consumption of, and markets for, United States agricultural products: *Provided, however*, That no such loans shall be made for the manufacture of any products to be exported to the United States in competition with products produced in the United States or for the manufacture or production of any commodity to be marketed in competition with United States agricultural commodities or the products thereof. Foreign currencies may be accepted in repayment of such loans;

(f) To pay United States obligations abroad;

(g) For loans to promote multilateral trade and economic development, made through established banking facilities of the friendly nation from which the foreign currency was obtained or in any other manner which the President may deem to be appropriate. Strategic materials, services, or foreign currencies may be accepted in payment of such loans;

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[14] As amended by the Act of September 21, 1959, 73 Stat. 607.

[15] As amended by Pub. L. 88–638, 78 Stat. 1035, approved October 8, 1964.
Sec. 420 of the Act of August 10, 1959, 73 Stat. 324 provides:
"SEC. 420. In carrying out a foreign country any project authorized by this Act or any other Military Construction Act heretofore or hereafter enacted, currencies of such country acquired pursuant to the provisions of the Agricultural Trade Development and Assistance Act of 1954 (Public Law 480, Eighty-third Congress) shall, to the extent available and feasible, be used in lieu of dollars. The Department of Defense shall reimburse the Commodity Credit Corporation for any foreign currencies so utilized in carrying out such projects." (7 U.S.C. 1704(b).)

[16] As amended by Pub. L. 88–638, 78 Stat. 1035, approved October 8, 1964, by the Act of September 4, 1961, 75 Stat. 463, and by the Act of August 13, 1957, 71 Stat. 345.

(h)[17] For the financing of international educational exchange activities under the programs authorized by section 32(b)(2) of the Surplus Property Act of 1944, as amended (50 U.S.C. App. 1641(b)) and for the financing in such amounts as may be specified from time to time in appropriation acts of programs for the interchange of persons under title II of the United States Information and Educational Exchange Act of 1948, as amended (22 U.S.C. 1446). In the allocation of funds as among the various purposes set forth in this section, a special effort shall be made to provide for the purposes of this subsection, including a particular effort with regard to: (1) countries where adequate funds are not available from other sources for such purposes, and (2) countries where agreements can be negotiated to establish a fund with the interest and principal available over a period of years for such purposes, such special and particular effort to include the setting aside of such amounts from sale proceeds and loan repayments under this title, not in excess of $1,000,000 a year in any one country for a period of not more than five years in advance, as may be determined by the Secretary of State to be required for the purposes of this subsection;

(i)[18] For financing the translation, publication, and distribution of books and periodicals, including Government publications, abroad: *Provided*, That not more than $5,000,000 may be allocated for this purpose during any fiscal year;

(j)[19] For providing assistance to activities and projects authorized by section 203 of the United States Information and Educational Exchange Act of 1948, as amended (22 U.S.C. 1448), but no foreign currencies which are available under the terms of any agreement for appropriation for the general use of the United States shall be used for the purposes of this subsection (j) without appropriation therefor;

(k)[20] To collect, collate, translate, abstract, and disseminate scientific and technological information and to conduct research and support scientific activities overseas including programs and projects of scientific cooperation between the United States and other countries such as coordinated research against diseases common to all of mankind or unique to individual regions of the globe, and to promote and support programs of medical and scientific research, cultural and educational development, health, nutrition, and sanitation: *Provided*, That foreign currencies shall be available for the purposes of this subsection (in addition to funds otherwise made available for such purposes) only in such amounts as may be specified from time to time in appropriation Acts;

(l)[21] For the acquisition by purchase, lease, rental or otherwise of sites and buildings and grounds abroad, for United States Government use including offices, residence quarters, community and other

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[17] As amended by the Act of July 18, 1956, 70 Stat. 564; Act of August 14, 1957, 71 Stat. 345; and Act of September 6, 1958, 72 Stat. 1790.

[18] Subsection (i) added by the Act of July 18, 1956, 70 Stat. 565.

[19] Subsection (j) added by the Act of August 3, 1956, 70 Stat. 988.

[20] Subsection (k) added by the Act of June 30, 1958, 72 Stat. 275. Subsection (k) was amended previously by the Act of July 24, 1959, 73 Stat. 258, and by the Act of September 21, 1959, 73 Stat. 607. See also the International Health Research Act of 1960, 74 Stat. 364, approved July 12, 1960, authorizing the President to enter into agreements with foreign nations or organizations to use foreign currencies for international health research. (22 U.S.C. 2103.)

[21] Subsections (l), (m), (n), and (o) were added by the Act of September 6, 1958, 72 Stat. 1791.

facilities, and for construction, repair, alteration and furnishing of such buildings and facilities: *Provided*, That foreign currencies shall be available for the purposes of this subsection (in addition to funds otherwise made available for such purposes) in such amounts as may be specified from time to time in appropriation acts;

(m)[21] For financing in such amounts as may be specified from time to time in appropriation acts (A) trade fair participation and related activities authorized by section 3 of the International Cultural Exchange and Trade Fair Participation Act of 1956 (22 U.S.C. 1992) or section 212(B) of the Merchant Marine Act, 1936,[22] and (B) agricultural and horticultural fair participation and related activities;

(n)[21] For financing under the direction of the Librarian of Congress, in consultation with the National Science Foundation and other interested agencies, in such amounts as may be specified from time to time in appropriations acts, (1) programs outside the United States for the analysis and evaluation of foreign books, periodicals, and other materials to determine whether they would provide information of technical or scientific significance in the United States and whether such books, periodicals, and other materials are of cultural or educational significance; (2) the registry, indexing, binding, reproduction, cataloging, abstracting, translating, and dissemination of books, periodicals, and related materials determined to have such significance; and (3) the acquisition of such books, periodicals, and other materials and the deposit thereof in libraries and research centers in the United States specializing in the areas to which they relate;

(o)[21] For providing assistance, in such amounts as may be specified from time to time in appropriation acts, by grant or otherwise, in the expansion or operation in foreign countries of established schools, colleges, or universities founded or sponsored by citizens of the United States, for the purpose of enabling such educational institutions to carry on programs of vocational, professional, scientific, technological, or general education;[23]

(p)[24] For supporting workshops in American studies or American educational techniques, and supporting chairs in American studies;

(q)[24] For assistance to meet emergency or extraordinary relief requirements other than requirements for surplus food commodities: *Provided*, That not more than a total amount equivalent to $5,000,000 may be made available for this purpose during any fiscal year;

(r)[24] For financing the preparation, distribution, and exhibiting of audio-visual informational and educational materials, including Government materials, abroad: *Provided*, That not more than a total amount equivalent to $2,500,000 may be made available for this purpose during any fiscal year, but nothing in this subsection shall limit or affect the use of foreign currencies to finance the preparation, distribution, or exhibition of such materials in connection with trade fairs and other market development activities under subsection (a);

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[21] See p. 199.

[22] The phrase "or section 212(B) of the Merchant Marine Act of 1936" was added by the Act of October 18, 1962, 76 Stat. 1074.

[23] Subsec. (p) was originally part of subsec. (o) but was separated by the Act of September 21, 1959, 73 Stat. 607.

[24] Subsecs. (p), (q), and (r) added by Act of September 21, 1959, 73 Stat. 607.

(s) [25] For the sale for dollars to American tourists under such terms and conditions as the President may prescribe;

(t) [26] For sale to United States citizens as provided herein. In order to provide for the foreign currency needs of United States citizens for travel or other purposes, the Secretary of the Treasury may make available for sale for United States dollars to such citizens, at United States embassies or other convenient locations, foreign currencies acquired by the United States through operations under the Foreign Assistance Act of 1961, as amended, the Mutual Security Act of 1954, as amended, or any Act repealed thereby, or the Agricultural Trade Development and Assistance Act of 1954, as amended, which (1) he determines to be in excess of the needs of departments and agencies of the United States for such currencies, and (2) are not prohibited from such use or committed to other uses by agreement heretofore entered into with another country. United States dollars received from the sale of foreign currencies under this subsection shall be deposited in the Treasury as miscellaneous receipts, except that in the case of any such foreign currencies acquired through operations under title I of the Agricultural Trade Development and Assistance Act of 1954, as amended, the United States dollars received from the sale of such foreign currencies shall be deposited to the account of the Commodity Credit Corporation and shall be treated as a reimbursement to Commodity Credit Corporation under section 105 of this Act.

Provided, however, That section 1415 of the Supplemental Appropriation Act, 1953,[27] shall apply to all foreign currencies used for grants under subsections (d) and (e) and for payment of United States obligations involving grants under subsection (f) and to not less than 10 per centum of the foreign currencies which accrue under this title pursuant to agreements entered into on or before December 31, 1964 and to not less than 20 per centum in the aggregate of the foreign currencies which accrue pursuant to agreements entered into thereafter: [28] *Provided, however*, That the President is authorized to waive such applicability of section 1415 in any case where he determines that it would be inappropriate or inconsistent with the purposes of this title: *Provided, however*, That no foreign currencies shall be available pursuant to subsections (k), (p), and (r), except in such amounts as may be specified from time to time in appropriation Acts.[29]

There is hereby established an advisory committee composed of the Secretary of Agriculture, the Director of the Bureau of the Budget, the Administrator of the Agency for International Development, the chairman and the ranking minority member of the House Committee on Agriculture, and the chairman and the ranking minority member

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[25] Subsec. (s) was added by the Agricultural Act of 1961, 75 Stat. 306, August 8, 1961.

[26] Subsec. (t) was originally sec. 612(b) of the Foreign Assistance Act of 1961, 77 Stat. 386, as amended by the Foreign Assistance Act of 1963, 77 Stat. 386, approved December 16, 1963. It was amended and redesignated subsec. (t) of the Agricultural Trade Development and Assistance Act of 1954, as amended, by Pub. L. 88–638, 78 Stat. 1037, 1038, approved October 8, 1964.

[27] Section 1415 provides that "Foreign credits owed to or owned by the United States Treasury will not be available for expenditure by agencies of the United States after June 30, 1953, except as may be provided for annually in appropriation Acts and provisions for the utilization of such credits for purposes authorized by law are hereby authorized to be included in general appropriation Acts."

[28] The preceding proviso was amended by Pub. L. 88–638, 78 Stat. 1036, approved October 8, 1964.

[29] The last proviso added by the Act of September 21, 1959, 73 Stat. 607, was amended by the Agricultural Act of 1961, 75 Stat. 306, August 8, 1961.

of the Senate Committee on Agriculture and Forestry. Such Committee shall review from time to time the status and usage of foreign currencies which accrue under this title, and shall make recommendations to the President as to ways and means of assuring to the United States (1) the maximum benefit from the use of such currencies, making special reference to any such currencies which are excess to the normal requirements of United States agencies, and (2) the maximum return from sales made under this title. Such Committee shall make such other recommendations for improving this Act and its administration as such Committee may deem fit.[30]

The committee shall be consulted with respect to: (1) policies relating to (a) loans under subsections (e) and (g) hereof, (b) the degree of convertibility to be required under section 101(g), and (c) the amount of currency to be reserved in sales agreements for loans to private industry under subsection (e) hereof; and (2) each proposal to establish an interest rate for dollar sales under title IV higher than the minimum provided in section 403.[30]

No agreement or proposal to grant any foreign currencies (except as provided in subsection (c) of this section), or to use (except pursuant to appropriation Act) any principal or interest from loan repayments under this section, shall be entered into or carried out until the expiration of thirty days following the date on which such agreement or proposal is transmitted by the President to the Senate Committee on Agriculture and Forestry and to the House Committee on Agriculture, if transmitted while Congress is in session, or sixty days following the date of transmittal if transmitted while Congress is not in session, and then only if, between the date of transmittal and the expiration of such period there has not been passed by either of the two Committees a resolution stating in substance that that Committee does not favor such agreement or proposal.[30]

Any loan made under the authority of this section shall bear interest at such rate as the President may determine but not less than the cost of funds to the United States Treasury, taking into consideration the current average market yields on outstanding marketable obligations of the United States having maturity comparable to the maturity of such loans, unless the President shall in specific instances upon the recommendation of the advisory committee herein established designate a different rate.[30] (7 U.S.C. 1704.)

SEC. 105.[31] Foreign currencies received pursuant to this title shall be deposited in a special account to the credit of the United States and shall be used only pursuant to section 104 of this title, and any department or agency of the government using any of such currencies for a purpose for which funds have been appropriated shall reimburse the Commodity Credit Corporation in an amount equivalent to the dollar value of the currencies used. The President shall utilize foreign currencies received pursuant to this title in such manner as will, to the maximum extent possible, reduce any deficit in the balance of payments of the United States. (7 U.S.C. 1705.)

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[30] These three paragraphs and the last sentence were added by Pub. L. 88–638, 78 Stat. 1036, approved October 8, 1964. See the President's statement on signing the bill.

[31] The last sentence was added by Pub. L. 88–205, 75 Stat. 390, approved December 16, 1963.

SEC. 106.[32] As used in this Act, "surplus agricultural commodity" shall mean any agricultural commodity or product thereof, class, kind, type, or other specification thereof, produced in the United States, either privately or publicly owned, which is at the time of exportation or donation in excess of domestic requirements, adequate carryover, and anticipated exports for dollars, as determined by the Secretary of Agriculture. The Secretary of Agriculture is also authorized to determine the nations with whom agreements shall be negotiated, and to determine the commodities and quantities thereof which may be included in the negotiations with each country after advising with other agencies of Government affected and within broad policies laid down by the President for implementing this Act. For the purposes of this title and title IV, the term "surplus agricultural commodity" shall include any domestically produced fishery product (not including fish flour until approved by the Food and Drug Administration) if the Secretary of the Interior has determined that such product is at the time of exportation in excess of domestic requirements, adequate carryover, and anticipated exports for dollars. (7 U.S.C. 1706.)

SEC. 107.[33] As used in this Act, "friendly nation" means any country, other than (1) the U.S.S.R., or (2) any nation or area dominated or controlled by the foreign government or foreign organization controlling the world Communist movement, or (3) for the purpose only of title I any nation or area dominated or controlled by a Communist government, or (4) for the purpose only of title I any nation which permits ships or aircraft under its registry to transport to or from Cuba (excluding United States installations in Cuba) any equipment, materials, or commodities, so long as Cuba is governed by the Castro regime. Notwithstanding any other Act, the President is authorized to enter into agreements for the sale of surplus agricultural commodities for dollars under title IV with nations which fall within the definition of "friendly nation" for the purpose of that title. In the case of any such agreement which would be prohibited by any other Act but for the foregoing sentence the maximum payment period shall be five years, instead of twenty years.

The President is directed that no sales under this Act shall be made with any country if he finds such country is (a) an aggressor, in a military sense, against any country having diplomatic relations with the United States, or (b) using funds, of any sort, from the United States for purposes inimical to the foreign policies of the United States. (7 U.S.C. 1707.)

SEC. 108. The President shall make a report to Congress with respect to the activities carried on under this Act at least once each year [34] and at such other times as may be appropriate and such reports shall include the dollar value, at the exchange rates in effect at the time of the sale, of the foreign currency for which commodities exported pursuant to section 102(a) hereof are sold. (7 U.S.C. 1708).

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[32] The last sentence was added by Pub. L. 88–205, 75 Stat. 390, approved December 16, 1963, and is effective as of January 1, 1965. The section was previously amended by the Act of August 12, 1955, 69 Stat. 721.

[33] Sec. 107 was amended by Pub. L. 88–638, 78 Stat. 1036, approved October 8, 1964, by adding all the language following the word "movement,".

[34] The word "year" was substituted for the words "six months" by Pub. L. 88–638, 78 Stat. 1037, approved October 8, 1964.

SEC. 109. No transactions shall be undertaken under authority of this title after December 31, 1966,[35] except as required pursuant to agreements theretofore entered into pursuant to this title. (7 U.S.C. 1709.)

TITLE II—FAMINE RELIEF AND OTHER ASSISTANCE[36]

SEC. 201. In order to enable the President to furnish emergency assistance on behalf of the people of the United States to friendly peoples in meeting famine or other urgent or extraordinary[37] relief requirements, the Commodity Credit Corporation shall make available to the President out of its stocks such surplus agricultural commodities (as defined in section 106 of title I)[38] as he may request, for transfer (1) to any nation friendly to the United States in order to meet famine or other urgent or extraordinary[37] relief requirements of such nation, and (2) to friendly but needy populations without regard to the friendliness of their government. (7 U.S.C. 1721.)

SEC. 202.[39] In order to facilitate the utilization of surplus agricultural commodities in meeting the requirements of needy peoples, and in order to promote economic and community development in underdeveloped areas in addition to that which can be accomplished under title I of this Act, the President may authorize the transfer on a grant basis of surplus agricultural commodities from Commodity Credit Corporation stocks to assist programs undertaken with friendly governments or through voluntary relief agencies: *Provided*, That the President shall take reasonable precaution that such transfers will not displace or interfere with sales which might otherwise be made. (7 U.S.C. 1722.)

SEC. 203.[40] Programs of assistance shall not be undertaken under this title during any calendar year beginning January 1, 1965, and ending December 31, 1966, which call for appropriations of more than $400,000,000 to reimburse the Commodity Credit Corporation for all costs incurred in connection with such programs (including the Corportion's investment in commodities made available), plus any amount by which programs of assistance undertaken in the preceding calendar year have called or will call for appropriations to reimburse the Commodity Credit Corporation in amounts less than were authorized for such purpose during such preceding year by this title as in effect during such preceding year. The President may make transfers through such agencies including intergovernmental organizations, in such manner, and upon such terms and conditions as he deems appropriate; he shall make use of the facilities of voluntary relief

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[35] "1966" was substituted for "1964" by Pub. L. 88–638, 78 Stat. 1037, approved October 8, 1964.

[36] See also Act of August 19, 1958, 72 Stat. 635 (p. 220), as to donations of processed grain food products.

[37] Words "or extraordinary" inserted in two places of the Act of August 3, 1956, 70 Stat. 988.

[38] Requirement that delivery be made "f.o.b. vessels in United States ports" removed by sec. 208(b) of Agricultural Act of 1956.

[39] This section was amended by Pub. L. 88–205, 77 Stat. 391, approved December 16, 1963; by the Act of July 20, 1961, 75 Stat. 211; and by the Act of May 14, 1960, 74 Stat. 140.

[40] The first sentence was substituted for the previous sentence by the Agricultural Act of 1961, 75 Stat. 307, August 8, 1961, and was further amended by Pub. L. 88–638, 78 Stat. 1037, approved October 8, 1964, by (1) substituting "1965" for "1961", "1966" for "1964" and "$400,000,000, for "$300,000,000". The last amendments are effective January 1, 1965.

agencies to the extent practicable. Such transfers may include delivery f.o.b. vessels in United States ports and, upon a determination by the President that it is necessary to accomplish the purposes of this title or of section 416 of the Agricultural Act of 1949, as amended, ocean freight charges from United States ports to designated ports of entry abroad, or, in the case of landlocked countries, transportation from United States ports to designated points of entry abroad, may be paid from funds available to carry out this title on commodities transferred pursuant hereto or donated under said section 416, and charges for general average contributions arising out of the ocean transport of commodities transferred pursuant hereto or donated under said section 416, section 308 of this Act or section 9 of the Act of September 6, 1958 (72 Stat. 1790) may be paid from such funds.[41] In addition to other funds available for such purposes under any other Act, funds made available under this title may be used in an amount not exceeding $7,500,000 annually to purchase foreign currencies accruing under title I in order to meet costs (except the personnel and administrative costs of cooperating sponsors, distributing agencies, and recipient agencies, and the costs of construction or maintenance of any church owned or operated edifice or any other edifices to be used for sectarian purposes) designed to assure that commodities made available under this title or under title III are used to carry out more effectively the purposes for which such commodities are made available or to promote community and other self-help activities designed to alleviate the causes of the need for such assistance: *Provided, however*, That such funds shall be used only to supplement and not substitute for, funds normally available for such purposes from other non-United States Government sources.[42] Funds required for ocean freight costs or for the purchase of foreign currencies authorized under this title may be transferred by the Commodity Credit Corporation to such other Federal agency as may be designated by the President.[43] (7 U.S.C. 1723.)

SEC. 204. No programs of assistance shall be undertaken under the authority of this title after December 31, 1966.[44] (7 U.S.C. 1724.)

TITLE III—GENERAL PROVISIONS

SEC. 301. [This section contains an amendment to section 407 of the Agricultural Act of 1949 (p. 160), authorizing Commodity Credit Corporation to make commodities available to relieve distress.]

SEC. 302. [This section contains a revision of section 416 of the Agricultural Act of 1949 (p. 165), which authorizes various methods of disposition by Commodity Credit Corporation of commodities in surplus supply.]

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[41] Pub. L. 88-638, 78 Stat. 1037, approved October 8, 1964, added the language appearing after the words "pursuant hereto" to "(72 Stat. 1790)". This sentence was initially added to sec. 203 by sec. 208(c) of the Agricultural Act of 1956, 70 Stat. 201, and was amended by the Act of May 14, 1960, 74 Stat. 140.

[42] The preceding sentence was added by Pub. L. 88-638, 78 Stat. 1037, approved October 8, 1964.

[43] The preceding sentence was added by sec. 208(e) of the Agricultural Act of 1956, 70 Stat. 201 and was further amended by Pub. L. 88-638, 78 Stat. 1037, approved October 8, 1964, by adding the words "or for the purchase of foreign currencies" after the word "costs."

[44] "1966" substituted for "1964" by Pub. L. 88-638, 78 Stat. 1037, approved October 8, 1964.

SEC. 303.[45] The Secretary shall, whenever he determines that such action is in the best interest of the United States, and to the maximum extent practicable, barter or exchange agricultural commodities owned by the Commodity Credit Corporation for (a) such strategic or other materials of which the United States does not domestically produce its requirements and which entail less risk of loss through deterioration or substantially less storage charges as the President may designate, or (b) materials, goods, or equipment required in connection with foreign economic and military aid and assistance programs, or (c) materials or equipment required in substantial quantities for offshore construction programs. He is hereby directed to use every practicable means, in cooperation with other Government agencies, to arrange and make, through private channels, such barters or exchanges or to utilize the authority conferred on him by section 4(h) of the Commodity Credit Corporation Charter Act, as amended, to make such barters or exchanges. In carrying out barters or exchanges authorized by this section, no restrictions shall be placed on the countries of the free world into which surplus agricultural commodities may be sold, except to the extent that the Secretary shall find necessary in order to take reasonable precautions to safeguard usual marketings of the United States and to assure that barters or exchanges under this Act will not unduly disrupt world prices of agricultural commodities or replace cash sales for dollars. The Secretary may permit the domestic processing of raw materials of foreign origin. The Secretary shall endeavor to cooperate with other exporting countries in preserving normal patterns of commercial trade with respect to commodities covered by formal multilateral international marketing agreements to which the United States is a party. Agencies of the United States Government procuring such materials, goods, or equipment are hereby directed to cooperate with the Secretary in the disposal of surplus agricultural commodities by means of barter or exchange. The Secretary is also directed to assist, through such means as are available to him, farmers' cooperatives in effecting exchange of agricultural commodities in their possession for strategic materials. (7 U.S.C. 1692.)

SEC. 304.[46] (a) The President shall exercise the authority contained in title I of this Act (1) to assist friendly nations to be independent of trade with the Union of Soviet Socialist Republics or the Communist regime in China and with nations dominated or controlled by the Union of Soviet Socialist Republics or the Communist regime in China and (2) to assure that agricultural commodities sold or transferred thereunder do not result in increased availability of those or like commodities to unfriendly nations.

(b)[47] Nothing in this Act shall be construed as authorizing transactions under title I or title III with the Union of Soviet Socialist Republics or any of the areas dominated or controlled by the Communist regime in China. (7 U.S.C. 1693.)

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[45] Sec. 303 was amended by the Act of September 6, 1958, 72 Stat. 1791.

[46] The words "or the Communist regime in China" appearing in clause (1) were added by Pub. L. 88–638, 78 Stat. 1037, approved October 8, 1964.

[47] The Act of August 13, 1957, 71 Stat. 345, amended this section by designating the existing provision as subsec. (a), restricting provisions thereof to title I transactions, eliminating the words "for food, raw materials and markets" preceding "and 2," and adding subsec. (b).

SEC. 305.[48] All Commodity Credit Corporation stocks donated abroad under title II of this Act and section 416 of the Agricultural Act of 1949, as amended, shall be clearly identified by appropriate marking on each package or container and insofar as practical in the language of the locality where such stocks are distributed as being furnished by the people of the United States of America and where available funds accruing under title I shall be used for this purpose. (7 U.S.C. 1694.)

SEC. 306.[49] [This section authorizing the Secretary of Agriculture to establish a Food Stamp Plan to distribute surplus foods domestically to needy peoples was effective till January 1962. See Agriculture Handbook 192, p. 189. A new Food Stamp Act was enacted in 1964. See p. 319.]

SEC. 307.[49] Whenever the Secretary of Agriculture determines under section 106 of this Act that any food commodity is a surplus agricultural commodity, insofar as practicable he shall make such commodity available for distribution to needy families and persons in the United States in such quantities as he determines are reasonably necessary before such commodity is made available for sale for foreign currencies under title I of this Act. (7 U.S.C. 1696.)

SEC. 308.[49] Notwithstanding any other provision of law, the Commodity Credit Corporation is hereby authorized—

(1) to dispose of its stocks of animal fats and edible oils or products thereof by donation, upon such terms and conditions as the Secretary of Agriculture deems appropriate, to nonprofit voluntary agencies registered with the Department of State, appropriate agencies of the Federal Government or international organizations, for use in the assistance of needy persons and in nonprofit school lunch programs [50] outside the United States;

(2) to purchase for donation as provided above such quantities of animal fats and edible oils and the products thereof as the Secretary determines will tend to maintain the support level for cottonseed and soybeans without requiring the acquisition of such commodities under the price support program.

Commodity Credit Corporation may incur such additional costs with respect to commodities to be donated hereunder as it is authorized to incur with respect to food commodities disposed of under section 416 of the Agricultural Act of 1949, and may pay ocean freight charges from United States ports to designated ports of entry abroad. (7 U.S.C. 1697.)

TITLE IV—LONG-TERM SUPPLY CONTRACTS [51]

SEC. 401. The purpose of this title is to utilize surplus agricultural commodities and the products thereof produced in the United States to

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[48] This section was substituted for the previous section by the Act of September 21, 1959, 73 Stat. 607.

[49] Secs. 306, 307 and 308 were added by the Act of September 21, 1959, 73 Stat. 608. See other authorities on donations of fats and oils on p. 222.

[50] The language "and in nonprofit school lunch programs" was added by the Food and Agriculture Act of 1962, 76 Stat. 611, September 27, 1962.

[51] Title IV was added by the Act of September 21, 1959, 73 Stat. 610.

assist the economic development of friendly nations by providing long-term credit for purchases of surplus agricultural commodities for domestic consumption during periods of economic development so that the resources and manpower of such nations may be utilized more effectively for industrial and other domestic economic development without jeopardizing meanwhile adequate supplies of agricultural commodities for domestic use. It is also the purpose of this title to stimulate and increase the sale of surplus agricultural commodities for dollars through long-term supply agreements and through the extension of credit for the purchase of such commodities, by agreements either with friendly nations or with the private trade, thereby assisting the development of the economies of friendly nations and maximizing dollar trade.[52] (7 U.S.C. 1731.)

SEC. 402. In furtherance of this purpose, the President is authorized to enter into agreements with friendly nations, including financial institutions acting in behalf of such nations,[53] under which the United States shall undertake to provide for delivery annually of certain quantities of such surplus agricultural commodities for periods of not to exceed ten years, pursuant to the terms and conditions set out in this title, providing such commodities are in surplus at the time delivery is to be made. In furtherance of the purpose of maximizing dollar sales through the private trade, the Secretary of Agriculture is authorized to enter into sales agreements with foreign and United States private trade under which he shall undertake to provide for the delivery of surplus agricultural commodities over such periods of time and under the terms and conditions set forth in this title. Any agreement entered into hereunder with the private trade shall provide for the furnishing of such security as the Secretary determines necessary to provide reasonable and adequate assurance of payment of the amount due for agricultural commodities sold pursuant to such agreement.[54] (7 U.S.C. 1732.)

SEC. 403.[55] Payment for such commodities shall be in dollars with interest at such rate as the Secretary may determine but not less than the minimum rate required by section 201 of the Foreign Assistance Act of 1961 for loans made under that section. Payment may be made in reasonable annual amounts over periods of not to exceed twenty years from the date of the last delivery of commodities in each calendar year under the agreement, except that the date for beginning such annual payment may be deferred for a period not later than two years after such date of last delivery, and interest shall be computed from the date of such last delivery. (7 U.S.C. 1733.)

SEC. 404. In carrying out the provisions of this title, the Secretary of Agriculture shall endeavor to maximize the sale of United States agricultural commodities taking such reasonable precautions as he determines necessary to avoid replacing any sales which the Secretary

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[52] The last sentence was added by the Food and Agriculture Act of 1962, 76 Stat. 610, September 27, 1962.

[53] The phrase "including financial institutions acting in behalf of such nations" was added by the Food and Agriculture Act of 1962, 76 Stat. 612, approved September 27, 1962.

[54] The last two sentences were added by the Food and Agriculture Act of 1962, 76 Stat. 611, September 27, 1962.

[55] The first sentence was amended by Pub. L. 88-638, 78 Stat. 1037, approved October 8, 1964. Sec. 403 was previously amended by the Food and Agriculture Act of 1962, 76 Stat. 611, September 27, 1962.

finds and determines would otherwise be made for cash dollars. (7 U.S.C. 1734.)

SEC. 405.[56] In the case of such agreements, the Secretary may enter into agreements with other friendly and historic supplying nations of such commodities for their participation in the supply and assistance program herein authorized on a proportionate and equitable basis. (7 U.S.C. 1735.)

SEC. 406.[57] In carrying out this title, the provisions of sections 101 (b) and (c), 102, 103(a), 106, 107, and 108 of this Act shall be applicable to the extent not inconsistent with this title. (7 U.S.C. 1736.)

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[56] Sec. 405 was amended by the Food and Agriculture Act of 1962, 76 Stat. 611, September 27, 1962.

[57] Sec. 406 amended by the Food and Agriculture Act of 1962, 76 Stat. 611, September 27, 1962.

SECTION 32 AND RELATED STATUTES

SECTION 32 OF PUBLIC LAW NO. 320, SEVENTY-FOURTH CONGRESS[1]

SEC. 32. There is hereby appropriated for each fiscal year beginning with the fiscal year ending June 30, 1936, an amount equal to 30 per centum of the gross receipts from duties collected under the customs laws during the period January 1 to December 31, both inclusive, preceding the beginning of each such fiscal year.[2] Such sums shall be maintained in a separate fund and shall be used by the Secretary of Agriculture only to (1) encourage the exportation of agricultural commodities and products thereof by the payment of benefits in connection with the exportation thereof or of indemnities for losses incurred in connection with such exportation or by payments to producers in connection with the production of that part of any agricultural commodity required for domestic consumption; (2) encourage the domestic consumption of such commodities or products by diverting them, by the payment of benefits or indemnities or by other means, from the normal channels of trade and commerce or by increasing their utilization through benefits, indemnities, donations or by other means, among persons in low-income groups as determined by the Secretary of Agriculture; and (3) reestablish farmers' purchasing power by making payments in connection with the normal production of any agricultural commodity for domestic consumption. Determinations by the Secretary as to what constitutes diversion and what constitutes normal channels of trade and commerce and what constitutes normal production for domestic consumption shall be final.

The sums appropriated under this section shall be expended for such one or more of the above-specified purposes, and at such times, in such manner, and in such amounts as the Secretary of Agriculture finds will effectuate substantial accomplishment of any one or more of the purposes of this section. Notwithstanding any other provision of this section, the amount that may be devoted, during any fiscal year after June 30, 1939, to any one agricultural commodity or the products thereof in such fiscal year, shall not exceed 25 per centum of the funds available under this section for such fiscal year. The sums appropriated under this section shall be devoted principally to perishable nonbasic agricultural commodities (other than those receiving price sup-

[1] The Act of August 24, 1935, 49 Stat. 750, 774. Although this section has been amended a number of times, the purposes of sec. 32—through payments or indemnities to encourage the exportation and domestic consumption of agricultural commodities and products and to reestablish farmers' purchasing power in connection with the normal production of agricultural commodities—remain basically as originally enacted. Authority to encourage consumption of agricultural commodities and products by their utilization among persons in low-income groups was added by amendment of clause (2) in 1939 (53 Stat. 975). Later amendments are noted below. Sec. 32 funds may be used (1) to purchase agricultural commodities and products and to donate them for relief purposes under the Act of June 28, 1937 (p. 212) and (2) to donate commodities to schools for utilization in school lunch programs under the National School Lunch Act (p. 311).

[2] Sec. 205 of the Agricultural Act of 1956 (p. 213) authorized the appropriation for each fiscal year, beginning with the fiscal year ending June 30, 1957, of $500,000,000 to enable the Secretary of Agriculture to further carry out the provisions of sec. 32, subject to all provisions of law relating to the expenditure of funds appropriated by such section, except that up to 50 percent of the $500,000,000 may be devoted during any fiscal year to any one agricultural commodity or the products thereof.

port under title II of the Agricultural Act of 1949)[3] and their products.[4] The sums appropriated under this section shall, notwithstanding the provisions of any other law, continue to remain available for the purposes of this section until expended; but any excess of the amount remaining unexpended at the end of any fiscal year over $300,000,000 shall, in the same manner as though it had been appropriated for the service of such fiscal year, be subject to the provisions of section 3690 of the Revised Statutes (U.S.C., title 31, sec. 712), and section 5 of the Act entitled "An Act making appropriations for the legislative, executive, and judicial expenses of the Government for the year ending June thirtieth, eighteen hundred and seventy-five and for other purposes" (U.S.C., title 31, sec. 714).[5] (7 U.S.C. 612c.)

ACT OF JUNE 28, 1937, AS AMENDED[6]

To extend the time for purchase and distribution of surplus agricultural commodities for relief purposes and to continue the Federal Surplus Commodities Corporation.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in carrying out the provisions of clause (2) of section 32 of the Act approved August 24, 1935 (49 Stat. 77), as amended, the Secretary of Agriculture may transfer to the Federal Surplus Commodities Corporation,[7] which Corporation is continued, until June 30, 1945, as an agency of the United States under the direction of the Secretary of Agriculture, such funds, appropriated by said section, as may be necessary for the purpose of effectuating clause (2) of said section: *Provided*, That such transferred funds, together with other funds of the Corporation, may be used for purchasing, exchanging, processing, distributing, disposing, transporting, storing, and handling of agricultural commodities and products thereof and inspection costs, commissions, and other incidental costs and expenses, without regard to the provisions of existing law governing the expenditure of public funds and for administrative expenses, including rent, printing and binding, and the employment of persons and means, in the District of Columbia, and elsewhere, such employment of persons to be in accordance with the provisions of law applicable to the employment of persons by the Agricultural Adjustment Administration.

In carrying out clause (2) of section 32, the funds appropriated by said section may be used for the purchase, without regard to the provisions of existing law governing the expenditure of public funds, of agricultural commodities and products thereof, and such commodities, as well as agricultural commodities and products thereof pur-

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[3] The clause within the parentheses was substituted for "other than those designated in title II of the Agricultural Act of 1949" by sec. 5 of the Act of January 30, 1954, 68 Stat. 4.

[4] This sentence was added by sec. 411 of the Agricultural Act of 1949, 63 Stat. 1057.

[5] This sentence was added by sec. 301 of the Agricultural Act of 1948, July 3, 1948, 62 Stat. 1257. See sec. 392(b) of the Agricultural Adjustment Act of 1938, as amended, p. 114, for limitation on administrative expenses.

[6] 50 Stat. 323; February 16, 1938, 52 Stat. 31, 38; June 27, 1942, 56 Stat. 461.

[7] The functions of the Federal Surplus Commodities Corporation have been transferred to the Secretary of Agriculture (7 U.S.C. 612a, note) and the Corporation has been dissolved.

chased under the preceding paragraph of this section, may be donated for relief purposes and for use in nonprofit summer camps for children.[8] (15 U.S.C. 713c.)

UTILIZATION OF COMMODITY CREDIT CORPORATION

Agricultural Act of 1949—Sec. 404. The Secretary, in carrying out programs under section 32 of Public Law Numbered 320, Seventy-fourth Congress, approved August 24, 1935, as amended, and section 6 of the National School Lunch Act, may utilize the services and facilities of the Commodity Credit Corporation (including but not limited to procurement by contract), and make advance payments to it. (7 U.S.C. 1424.)

APPROPRIATION TO SUPPLEMENT SECTION 32 FUNDS

Agricultural Act of 1956—Sec. 205. There is hereby authorized to be appropriated for each fiscal year, beginning with the fiscal year ending June 30, 1957, the sum of $500,000,000 to enable the Secretary of Agriculture to further carry out the provisions of section 32, Public Law 320, Seventy-fourth Congress, as amended (7 U.S.C. 612c), subject to all provisions of law relating to the expenditure of funds appropriated by such section, except that up to 50 per centum of such $500,000,000 may be devoted during any fiscal year to any one agricultural commodity or the products thereof. (7 U.S.C. 1855.)

ACT OF AUGUST 1939[9]

To authorize the Federal Surplus Commodities Corporation to purchase and distribute surplus products of the fishing industry.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress asembled, That any part of the funds not to exceed $1,500,000 per year, transferred by the Secretary of Agriculture to the Federal Surplus Commodities Corporation[10] created under and to carry out the provisions of section 32 of the Act of August 24, 1935 (49 Stat. 774), as amended, may also be used by such Corporation for the purpose of diverting surplus fishery products (including fish, shellfish, mollusks, and crustacea) from the normal channels of trade and commerce by acquiring them and providing for their distribution through Federal, State, and private relief channels: *Provided*, That none of the funds made available to the Federal Surplus Commodities Corporation under this Act shall be used to purchase any of the commodities designated in this Act which may have been produced in any foreign country. The provisions of law relating to the acquisition of materials or supplies for the United States shall not apply to the acquisition of commodities under this Act. (15 U.S.C. 713c–2.)

Sec. 2. (a) The Secretary of Agriculture shall transfer to the Secretary of the Interior each fiscal year, beginning with the fiscal

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[8] The last nine words were added by the Act of July 2, 1958, 72 Stat. 286.
[9] 53 Stat. 1411.
[10] The functions of the Federal Surplus Commodities Corporation have been transferred to the Secretary of Agriculture (7 U.S.C. 612a note) and the Corporation has been dissolved.

year commencing July 1, 1954, and ending on June 30, 1957,[11] from moneys made available to carry out provisions of section 32 of such Act of August 24, 1935, an amount equal to 30 per centum of the gross receipts from duties collected under the customs laws on fishery products (including fish, shellfish, mollusks, crustacea, aquatic plants and animals, and any products thereof, including processed and manufactured products), which shall be maintained in a separate fund and used by the Secretary of the Interior (1) to promote the free flow of domestically produced fishery products in commerce by conducting a fishery educational service and fishery technological, biological and related research programs, the moneys so transferred to be also available for the purchase or other acquisition, construction, equipment, operation, and maintenance of vessels or other facilities necessary for conducting research as provided for in this section, and (2) to develop and increase markets for fishery products of domestic origin and (3) to conduct any biological, technological, or other research pertaining to American fisheries.

(b) For the purposes of this section, any agency of the United States, or any corporation wholly owned by the United States, is authorized to transfer, without reimbursement or transfer of funds, any vessels or equipment excess to its needs required by the Secretary of the Interior for the activities, studies, and research authorized herein.

(c) In carrying out the puposes and objectives of this section, the Secretary of the Interior is directed as far as practicable to cooperate with other appropriate agencies of the Federal Govenment, with State or local governmental agencies, private agencies, organizations, or individuals, having jurisdiction over or an interest in fish or fishery commodities and he is authorized to appoint an advisory committee of the American fisheries industry to advise him in the formulation of policy, rules and regulations pertaining to requests for assistance, and other matters.

(d) The Secretary of the Interior is further authorized to retransfer any of the funds not to exceed $1,500,000 to be made available under this section to the Secretary of Agriculture to be used for the purposes specified in section 1 of this Act, and only such funds as are thus transferred shall be used for the purposes specified in section 1 of this Act with respect to domestically produced fishery products.

(e) The separate fund created for the use of the Secretary of the Interior under section 2 (a) of this Act and the annual accruals thereto shall be available for each year until expended by the Secretary.

(f) The Secretary of the Interior shall make a report to the appropriate committees of Congress annually on the use of the separate fund created under section 2 of this Act.[12] (15 U.S.C. 713c–3.)

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[11] Sec. 12(a) of the Act of August 8, 1956 (70 Stat. 1124, 15 U.S.C. 713c–3 note) provides:

"The authorization for the transfer of certain funds from the Secretary of Agriculture to the Secretary of the Interior and their maintenance in a separate fund as contained in section 2(a) of the Act of August 11, 1939, as amended July 1, 1954 (68 Stat. 376), shall be continued for the year ending June 30, 1957, and each year thereafter."

[12] The provisions of this section were substituted for the original provisions by the Act of July 1, 1954, 68 Stat. 376. Subsection (e) was amended by the Act of August 8, 1956, 70 Stat. 1124.

DONATIONS TO AREAS UNDER U.S. JURISDICTION

Act of September 6, 1958.—SEC. 9. Notwithstanding any other provision of law (1) those areas under the jurisdiction or administration of the United States are authorized to receive from the Department of Agriculture for distribution on the same basis as domestic distribution in any State, Territory, or possession of the United States, without exchange of funds, such surplus commodities as may be available pursuant to clause (2) of section 32 of the Act of August 24, 1935, as amended (7 U.S.C. 612c), and section 416 of the Agricultural Act of 1949, as amended (7 U.S.C. 1431); * * *. (7 U.S.C. 1431b, 72 Stat. 1792.)

Department of the Interior and Related Agencies Appropriation Act, 1965.—Trust Territory of the Pacific Islands—* * * *Provided further*, That notwithstanding the provisions of any law, the Trust Territory of the Pacific Islands is authorized to receive, during the current fiscal year, from the Department of Agriculture for distribution on the same basis as domestic distribution in any State, Territory, or possession of the United States, without exchange of funds, such surplus food commodities as may be available pursuant to section 32 of the Act of August 24, 1935, as amended (7 U.S.C. 612c), and section 416 of the Agricultural Act of 1949, as amended (7 U.S.C. 1431.) (78 Stat. 278.)

SUBPART F—DONATIONS

[A number of authorities for donations are found in the following statutes which are set forth in other parts of this compilation as indicated:

	Page
Clause 2 of Section 32 of the Act of August 24, 1935 (programs to encourage domestic consumption)	211
Act of June 28, 1937, as amended (donation for relief purposes and nonprofit children's summer camp)	212
Sections 6 and 9 of the National School Lunch Act (donation for school-lunch)	312, 314
Title II of the Agricultural Trade Development and Assistance Act of 1954, as amended (donation for famine relief and other assistance abroad)	204

In addition to the foregoing, there are also the following statutes relating to donations; some of which affect one or more of the above authorities.]

DISPOSITION OF COMMODITIES TO PREVENT WASTE

Agricultural Act of 1949.—SEC. 416.[1] In order to prevent the waste of commodities whether in private stocks or [2] acquired through price-support operations by the Commodity Credit Corporation before they can be disposed of in normal domestic channels without impairment of the price-support program or sold abroad at competitive world prices, the Commodity Credit Corporation is authorized, on such terms and under such regulations as the Secretary may deem in the public interest: (1) upon application, to make such commodities available to any Federal agency for use in making payment for commodities not produced in the United States; (2) to barter or exchange such commodities for strategic or other materials as authorized by law; (3) in the case of food commodities to donate such commodities to the Bureau of Indian Affairs and to such State, Federal, or private agency or agencies as may be designated by the proper State or Federal authority and approved by the Secretary, for use in the United States in nonprofit school-lunch programs,[3] in nonprofit summer camps for children,[4] in the assistance of needy persons, and in charitable institutions, including hospitals, to the extent that needy persons are served; and (4) to donate any such food commodities in excess of anticipated disposition under (1), (2), and (3) above to nonprofit voluntary agencies registered with the Committee on Voluntary Foreign Aid of the Foreign Operations Administration or other

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[1] The provisions of this section were substituted for the previous provisions by sec. 302 of the Agricultural Trade Development and Assistance Act of 1954, 68 Stat. 458. See sec. 9 of the Act of September 6, 1958, 72 Stat. 1792 and the Department of the Interior and Related Agencies Appropriation Act, 1965 (both on p. 215), providing for distribution of commodities under sec. 416 to overseas areas under the jurisdiction or administration of the United States. See also sec. 305 of the Agricultural Trade Development and Assistance Act of 1954, providing for the identification of stocks disposed of under sec. 416 as being furnished by the people of the United States.

[2] The words "whether in private stocks or" were added by the Act of July 24, 1959, 73 Stat. 250.

[3] See Act of September 13, 1960, 74 Stat. 899 (p. 220) authorizing the use of surplus foods for training home economics students.

[4] The words "in nonprofit summer camps for children," were added by the Act of July 2, 1958, 72 Stat. 286.

appropriate department or agency of the Federal Government and intergovernmental organizations for use in the assistance of needy persons and in nonprofit school lunch programs [5] outside the United States. In the case of (3) and (4) above the Secretary shall obtain such assurance as he deems necessary that the recipients thereof will not diminish their normal expenditures for food by reason of such donation. In order to facilitate the appropriate disposal of such commodities, the Secretary may from time to time estimate and announce the quantity of such commodities which he anticipates will become available for distribution under (3) and (4) above. The Commodity Credit Corporation may pay, with respect to commodities disposed of under this section, reprocessing, packaging, transporting, handling, and other charges accruing up to the time of their delivery to a Federal agency or to the designated State or private agency, in the case of commodities made available for use within the United States, or their delivery free alongside ship or free on board export carrier at point of export, in the case of commodities made available for use outside the United States. In addition, in the case of food commodities disposed of under this section, the Commodity Credit Corporation may pay the cost of processing such commodities into a form suitable for home or institutional use, such processing to be accomplished through private trade facilities to the greatest extent possible.[6] For the purpose of this section the terms "State" and "United States" include the District of Columbia and any Territory or possession of the United States. The assistance to needy persons provided in (4) above shall, insofar as practicable, be directed toward community and other self-help activities designed to alleviate the causes of the need for such assistance.[7] (7 U.S.C. 1431.)

DOMESTIC DISPOSAL OF DAIRY PRODUCTS

Agricultural Act of 1954.—SEC. 204. (c) In order to prevent the accumulation of excessive inventories of dairy products the Secretary of Agriculture shall undertake domestic disposal programs under authorities granted in the Agricultural Adjustment Act of 1938 and the Agricultural Act of 1949, as amended, or as otherwise authorized by law. (7 U.S.C. 1446c.)

MILK FOR CHILDREN

ACT OF JULY 1, 1958,[8] AS AMENDED

AN ACT

To continue the special milk program for children in the interest of improved nutrition by fostering the consumption of fluid milk in the schools.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That for the fiscal year beginning July 1, 1959, not to exceed $85,000,000, and for the fiscal year beginning July 1, 1960, not to exceed $95,000,000, and for

[5] The phrase "and in nonprofit school lunch programs" was added by Food and Agriculture Act of 1962, 76 Stat. 611, September 27, 1962.
[6] This sentence was added by the Agricultural Act of 1956, 70 Stat. 203.
[7] This sentence was added by Pub. L. 88–638, 78 Stat. 1038, approved October 8, 1964.
[8] 72 Stat. 276.

the fiscal year beginning July 1, 1961, not to exceed $105,000,000, of the funds of the Commodity Credit Corporation shall be used to increase the consumption of fluid milk by children (1) in nonprofit schools of high-school grade and under; and (2) in nonprofit nursery schools, child-care centers, settlement houses, summer camps, and similar nonprofit institutions devoted to the care and training of children. There is authorized to be appropriated for the purposes of this Act for the fiscal year beginning July 1, 1960, separate from any other appropriation of funds for Commodity Credit Corporation, such amount as may be deemed to be necessary to reimburse Commodity Credit Corporation for amounts advanced by it under this Act. Amounts expended hereunder and under the authority contained in the last sentence of section 201(c) of the Agricultural Act of 1949, as amended, shall not be considered as amounts expended for the purpose of carrying out the price-support program.[9]

SEC. 2. There is hereby authorized to be appropriated for the fiscal year beginning July 1, 1962, and for each of the four fiscal years thereafter, such sums as may be necessary to enable the Secretary of Agriculture, under such rules and regulations as he may deem in the public interest, to encourage consumption of fluid milk by children in the United States in (1) nonprofit schools of high school grade and under, and (2) nonprofit nursery schools, child-care centers, settlement houses, summer camps, and similar nonprofit institutions devoted to the care and training of children. For the purposes of this Act, "United States" means the 50 States and the District of Columbia.[10] (7 U.S.C. 1446 note.)

TRANSFER OF DAIRY PRODUCTS TO THE MILITARY AND VETERANS HOSPITALS

Agricultural Act of 1949—SEC. 202.[11] As a means of increasing the utilization of dairy products (including for purposes of this section, milk) upon the certification by the Administrator of Veterans' Affairs or by the Secretary of the Army, acting for the military departments under the Department of Defense's Service Purchase Assignment for Subsistence, or their duly authorized representatives that the usual quantities of dairy products have been purchased in the normal channels of trade—

(a) The Commodity Credit Corporation until December 31, 1967,[12] shall make available to the Administrator of Veterans' Affairs at warehouses where dairy products are stored, such dairy products acquired under price-support programs as the Administrator certifies that he requires in order to provide butter and cheese and other dairy products as a part of the ration in hospitals under his jurisdiction. The Administrator shall report every six months[13] to the Committees on Agriculture of the Senate and House of Representatives and

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[9] Sec. 1 amended by Act of April 29, 1960, 74 Stat. 84, and by Act of June 30, 1961, 75 Stat. 147.

[10] Sec. 2 added by the Agricultural Act of 1961, 75 Stat. 319, August 8, 1961.

[11] Sec. 202 added by sec. 204(d) of the Agricultural Act of 1954, 68 Stat. 900.

[12] "1967" substituted for "1964" by Pub. L. 88–529, 78 Stat. 737, approved August 31, 1964.

[13] "every six months" substituted for "monthly" by the Act of June 25, 1962, 76 Stat. 109.

the Secretary of Agriculture the amount of dairy products used under this subsection.

(b) The Commodity Credit Corporation until December 31, 1967,[12] shall make available to the Secretary of the Army, at warehouses where dairy products are stored, such dairy products acquired under price-support programs as the Secretary of the Army or his duly authorized representative certifies can be utilized in order to provide additional butter and cheese and other dairy products as a part of the ration (1) of the Army, Navy, Air Force, or Coast Guard, (2) in hospitals under the jurisdiction of the Department of Defense, and (3) of cadets and midshipmen at, and other personnel assigned to, the United States Merchant Marine Academy. The Secretary of the Army shall report every six months to the Committees on Agriculture of the Senate and the House of Representatives and the Secretary of Agriculture the amount of dairy products used under this subsection.

(c) Dairy products made available under this section shall be made available without charge, except that the Secretary of the Army or the Administrator of Veterans' Affairs shall pay the Commodity Credit Corporation the costs of packaging incurred in making such products so available.

(d) The obligation of the Commodity Credit Corporation to make dairy products available pursuant to the above shall be limited to dairy products acquired by the Corporation through price-support operations and not disposed of under provisions (1) and (2) of section 416 of this Act, as amended. (7 U.S.C. 1446a.)

SURPLUS FOODS FOR HOME ECONOMIC COURSES

ACT OF SEPTEMBER 13, 1960,[14] AS AMENDED[15]

To authorize the Commodity Credit Corporation to donate dairy products and other agricultural commodities for use in home economics courses.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That schools receiving surplus foods pursuant to clause (3) of section 416 of the Agricultural Act of 1949 (7 U.S.C. 1431) or section 32 of the Act of August 24, 1935, as amended (7 U.S.C. 612c) are authorized to use such foods in training students in home economics, including college students if the same facilities and instructors are used for training both high school and college students in home economics courses. (7 U.S.C. 1431 note.)

DONATIONS OF PROCESSED GRAIN FOOD PRODUCTS

ACT OF AUGUST 19, 1958,[16] AS AMENDED[17]

Authorizing Commodity Credit Corporation to purchase flour and cornmeal and donating same for certain domestic and foreign purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That at any time

[14] 74 Stat. 899.
[15] Amended by the Act of August 30, 1961, 75 Stat. 411.
[16] 72 Stat. 635, 7 U.S.C. 1431 note.
[17] Pub. L. 88–550, 78 Stat. 755, approved August 31, 1964.

Commodity Credit Corporation has any grain available for donation pursuant to clause (3) or (4) of section 416 of the Agricultural Act of 1949, as amended, section 210 of the Agricultural Act of 1956, or title II of the Agricultural Trade Development and Assistance Act, as amended, the Corporation, in lieu of processing all or any part of such grain into human food products, may purchase such processed food products in quantities not to exceed the equivalent of the respective grain available for donation on the date of such purchase and donate such processed food products pursuant to clause (3) or (4) of such section 416, and to such section 210, and make such processed food products available to the President pursuant to such title II, and may sell, without regard to the provisions of section 407 of the Agricultural Act of 1949, as amended, a quantity of the grain equivalent to the processed food products so purchased: *Provided*, That no food product purchased pursuant to the authority contained herein shall constitute less than 50 per centum by weight of the grain from which processed, or contain any additive other than for normal vitamin enrichment, preservative, and bleaching purposes. (7 U.S.C. 1431 note.)

DONATIONS TO PENAL AND CORRECTIONAL INSTITUTIONS

Agricultural Act of 1956—Sec. 210. Notwithstanding any other limitations as to the disposal of surplus commodities acquired through price support operations, the Commodity Credit Corporation is authorized on such terms and under such regulations as the Secretary of Agriculture may deem in the public interest, and upon application, to donate food commodities acquired through price support operations to Federal penal and correctional institutions, and to State correctional institutions for minors, other than those in which food service is provided for inmates on a fee, contract, on concession basis. (70 Stat. 202, 7 U.S.C. 1859.)

COTTON FOR COLLEGES

Agricultural Act of 1958—Sec. 505. Commodity Credit Corporation is authorized, on such terms as the Secretary of Agriculture may approve, to donate cotton acquired through its price support operations to educational institutions for use in the training of students in the processing and manufacture of cotton into textiles. (72 Stat. 996, 7 U.S.C. 1431a.)

ENRICHMENT OF AND SANITARY CONTAINERS FOR CORNMEAL, GRITS, RICE, AND WHITE FLOUR DISTRIBUTION

Act of September 21, 1959—Sec. 201. (a) In order to insure the nutritional value of cornmeal, grits, rice, and white flour when such foods are made available for distribution under section 416(3) of the Agricultural Act of 1949 or for distribution to schools under the National School Lunch Act or any other Act, such foods shall be enriched so as to meet the standards for enriched cornmeal, enriched corn grits, enriched rice, or enriched flour, as the case may be, prescribed in regulations promulgated under the Federal Food, Drug, and Cosmetic Act; and in order to protect the nutritional value and

sanitary quality of such enriched foods during transportation and storage such foods shall be packaged in sanitary containers. For convenience and ease in handling, the weight of any sanitary container when filled shall not exceed fifty pounds unless a larger container is requested by the recipient agency.[18] Nothing in this section shall prohibit the distribution of fortified parboiled rice which is substantially equal in nutritional value to that of enriched rice.[19]

(b) The term "sanitary container" means any container of such material and construction as (1) will not permit the infiltration of foreign matter into the contents of such container under ordinary conditions of shipping and handling, and (2) will not, for a period of at least one year, disintegrate so as to contaminate the contents of the container, necessitating the washing of the contents prior to use. (73 Stat. 610, 7 U.S.C. 1431c.)

DONATIONS TO AREAS UNDER U.S. JURISDICTION—DONATIONS OF FATS AND OILS

Act of September 6, 1958—SEC. 9. Notwithstanding any other provision of law (1) those areas [20] under the jurisdiction or administration of the United States are authorized to receive from the Department of Agriculture for distribution on the same basis as domestic distribution in any State, Territory, or possession of the United States, without exchange of funds, such surplus commodities as may be available pursuant to clause (2) of section 32 of the Act of August 24, 1935, as amended (7 U.S.C. 612c), and section 416 of the Agricultural Act of 1949, as amended (7 U.S.C. 1431); and (2) the Commodity Credit Corporation is authorized to purchase products of oil seeds, and edible oils and fats and the products thereof in such form as may be needed for donation abroad as provided in the following sentence. Any such commodities or products if purchased shall be donated to nonprofit voluntary agencies registered with the Department of State, other appropriate agencies of the Federal Government or international organizations for use in the assistance of needy persons and in nonprofit school lunch programs [21] outside the United States. Commodity Credit Corporation may incur such additional costs with respect to such oil as it is authorized to incur with respect to food commodities disposed of under section 416 of the Agricultural Act of 1949. (7 U.S.C. 1431b, 72 Stat. 1792.)

Agricultural Trade Development and Assistance Act of 1954, as amended—SEC. 308. Notwithstanding any other provision of law, the Commodity Credit Corporation is hereby authorized—

(1) to dispose of its stocks of animal fats and edible oils or products thereof by donation, upon such terms and conditions as

[18] Clause beginning with "unless" added by the Act of October 11, 1962.

[19] This sentence and all other references to rice in sec. 201(a) were added by the Act of October 11, 1962, 76 Stat. 910.

[20] The Department of the Interior and Related Agencies Appropriation Act, 1965, provides for the Trust Territory of the Pacific Islands— * * * *Provided further*, That notwithstanding the provisions of any law, the Trust Territory of the Pacific Islands is authorized to receive, during the current fiscal year, from the Department of Agriculture for distribution on the same basis as domestic distribution in any State, Territory, or possession of the United States, without exchange of funds, such surplus food commodities as may be available pursuant to section 32 of the Act of August 24, 1935, as amended (7 U.S.C. 612c), and section 416 of the Agricultural Act of 1949, as amended (7 U.S.C. 1431). (78 Stat. 278.)

[21] The phrase "and in nonprofit school lunch programs," was added by the Food and Agriculture Act of 1962, 76 Stat. 611, approved September 27, 1962.

the Secretary of Agriculture deems appropriate, to nonprofit voluntary agencies registered with the Department of State, appropriate agencies of the Federal Government or international organizations, for use in the assistance of needy persons and in noprofit school lunch programs [21] outside the United States;

(2) to purchase for donation as provided above such quantities of animal fats and edible oils and the products thereof as the Secretary determines will tend to maintain the support level for cottonseed and soybeans without requiring the acquisition of such commodities under the price support program.

Commodity Credit Corporation may incur such additional costs with respect to commodities to be donated hereunder as it is authorized to incur with respect to food commodities disposed of under section 416 of the Agricultural Act of 1949, and may pay ocean freight charges from United States ports to designated ports of entry abroad.[22] (7 U.S.C. 1697.)

FOREIGN SCHOOL FEEDING PROGRAMS

Food and Agriculture Act of 1962—SEC. 205. In any school feeding programs undertaken hereafter outside the United States pursuant to section 416 of the Agricultural Act of 1949, as amended, section 308 of Public Law 480 (83d Congress), as amended, and section 9 of the Act of September 6, 1958, as amended, the Secretary shall receive assurances satisfactory to him that, insofar as practicable, there will be student participation in the financing of such programs on the basis of ability to pay, and such programs shall be undertaken with the understanding that commodities will be available for those programs only in accordance with the provisions of such statutes and that commodities made available under section 416 of the Agricultural Act of 1949, as amended, will be available only in accordance with the priorities established in such section. (76 Stat. 611, 7 U.S.C. 1431d.)

DONOR IDENTIFICATION

Agricultural Trade Development and Assistance Act of 1954, as amended—Sec. 305. All Commodity Credit Corporation stocks donated abroad under title II of this Act and section 416 of the Agricultural Act of 1949, as amended, shall be clearly identified by appropriate marking on each package or container and insofar as practical in the language of the locality where such stocks are distributed as being furnished by the people of the United States of America and where available funds accruing under title I shall be used for this purpose. (7 U.S.C. 1694.)

DOMESTIC DISTRIBUTION OF SURPLUS FOODS AVAILABLE FOR GRANT OR FOREIGN CURRENCY SALES

Mutual Security Act of 1954, as amended—Sec. 402. Of the funds authorized to be made available in the fiscal year 1961 pursuant to this Act (other than funds made available pursuant to title II), not less than $175,000,000 shall be used to finance the export and sale for

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[21] See footnote on p. 222.

[22] Enacted by the Act of September 21, 1959, 73 Stat. 609. See sec. 304(b) of the Agricultural Trade Redevelopment and Assistanee Act of 1954, with respeet to limitation on uses of this authority with respeet to Communist controlled areas.

foreign currencies or the grant of surplus agricultural commodities or products thereof produced in the United States, in addition to surplus agricultural commodities or products transferred pursuant to the Agricultural Trade Development and Assistance Act of 1954, and in accordance with the standards as to pricing and the use of private trade channels expressed in section 101 of said Act. Foreign currency proceeds accruing from such sales shall be used for the purpose of this Act and with particular emphasis on the purposes of section 104 of the Agricultural Trade Development and Assistance Act of 1954 which are in harmony with the purposes of this Act. Notwithstanding section 1415 of the Supplemental Appropriation Act, 1953, or any other provision of law, the President may use or enter into agreements with friendly nations or organizations of nations to use for such purposes the foreign currencies which accrue to the United States under this section. Surplus food commodities or products thereof made available for transfer under this Act (or any other Act) as a grant or as a sale for foreign currencies may also be made available to the maximum extent practicable to eligible domestic recipients pursuant to section 416 of the Agricultural Act of 1949, as amended (7 U.S.C. 1431), or to needy persons within the United States pursuant to clause (2) of section 32 of the Act of August 24, 1935, as amended (7 U.S.C. 612c). (22 U.S.C. 1922.)

DOMESTIC DONATIONS BEFORE FOREIGN CURRENCY SALES

Agricultural Trade Development and Assistance Act of 1954, as amended—Sec. 307. Whenever the Secretary of Agriculture determines under section 106 of this Act that any food commodity is a surplus agricultural commodity, insofar as practicable he shall make such commodity available for distribution to needy families and persons in the United States in such quantities as he determines are reasonably necessary before such commodity is made available for sale for foreign currencies under title I of this Act. (73 Stat. 609, 7 U.S.C. 1696.)

SUBPART G—FARM DISASTER RELIEF

[See also Secs. 103(a) and 107(a)(3) of the Soil Bank Act on pp. 118 and 121.]

Act of September 30, 1950—Sec. 2. As used in this Act, the following terms shall be construed as follows unless a contrary intent appears from the context:

(a) "Major disaster" means any flood, drought, fire, hurricane, earthquake, storm, or other catastrophe in any part of the United States which, in the determination of the President, is or threatens to be of sufficient severity and magnitude to warrant disaster assistance by the Federal Government to supplement the efforts and available resources of States and local governments in alleviating the damage, hardships, or suffering caused thereby, and respecting which the governor of any State (or the Board of Commissioners of the District of Columbia) in which such catastrophe may occur or threaten certifies the need for disaster assistance under this Act, and shall give assurance of expenditure of a reasonable amount of the funds of the government of such State, local governments therein, or other agencies, for the same or similar purposes with respect to such catastrophe;

(b)[1] "United States" includes the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Trust Territory of the Pacific Islands.

(c)[1] "State" means any State in the United States, Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Trust Territory of the Pacific Islands.

(d) "Governor" means the chief executive of any State;

(e) "Local government" means any county, city, village, town, district, or other political subdivision of any State, or the District of Columbia;

(f) "Federal agency" means any department, independent establishment, Government corporation, or other agency of the executive branch of the Federal Government, excepting, however, the American National Red Cross. (42 U.S.C. 1855a.)

Sec. 3. In any major disaster, Federal agencies are hereby authorized when directed by the President to provide assistance (a) by utilizing or lending, with or without compensation therefor, to States and local governments their equipment, supplies, facilities, personnel, and other resources, other than the extension of credit under the authority of any Act; * * * (c) by donating or lending equipment and supplies, determined under then existing law to be surplus to the needs and responsibilities of the Federal Government, to States for use or distribution by them for the purposes of the Act including the restoration of public facilities damaged or destroyed in such major disaster and essential rehabilitation of individuals in need as the result of such major disaster; (d) * * * The authority conferred

[1] Subsecs. (b) and (c) amended by the Act of June 27, 1962, 76 Stat. 111.

by this Act, and any funds provided hereunder shall be supplementary to, and not in substitution for, nor in limitation of, any other authority conferred or funds provided under any other law. Any funds received by the Federal agencies as reimbursement for services or supplies furnished under the authority of this section shall be deposited to the credit of the appropriation or appropriations currently available for such services or supplies. The Federal Government shall not be liable for any claim based upon the exercise or performance or the failure to exercise or perform a discretionary function or duty on the part of a Federal agency or an employee of the Government in carrying out the provisions of this section. (64 Stat. 1109; as amended by the Act of July 17, 1953, 67 Stat. 180; 42 U.S.C. 1855b.)

Agricultural Act of 1949, as amended.—SEC. 407. * * * Notwithstanding the foregoing, the Corporation, on such terms and conditions as the Secretary may deem in the public interest, shall make available any farm commodity or product thereof owned or controlled by it for use in relieving distress (1) in any area in the United States including the Virgin Islands [2] declared by the President to be an acute distress area because of unemployment or other economic cause if the President finds that such use will not displace or interfere with normal marketing of agricultural commodities and (2) in connection with any major disaster determined by the President to warrant assistance by the Federal Government under Public Law 875, Eighty-first Congress, as amended (42 U.S.C. 1855) [3] and shall make feed owned or controlled by it available at any price not less than 75 per centum of the current basic county support rate for such feed including the value of any applicable price support payment in kind (or a comparable price if there is no current basic county support rate) for assistance in the preservation and maintenance of foundation herds of cattle (including producing dairy cattle), sheep, and goats, and their offspring, in any area of the United States including the Virgin Islands [2] where, because of flood, drought, fire, hurricane, earthquake, storm, disease, insect infestation, or other catastrophe in such areas, the Secretary determines that an emergency exists which warrants such assistance, such feed to be made available only to persons who do not have, and are unable to obtain through normal channels of trade without undue financial hardship, sufficient feed for such livestock: *Provided*,[4] That the Secretary may provide for the furnishing of feed or mixed feed, in accordance with regulations prescribed by him, to such persons by feed dealers under an arrangement whereby the feed grains (or other feed being sold by the Corporation) in the feed so furnished would be replaced with feed owned or controlled by the Corporation and sold to such persons at a price determined as provided above. Except on a reimbursable basis, the Corporation shall not bear any costs in connection with making such commodity available beyond the cost of the commodities to the Corporation in store and the handling and trans-

[2] The words "including the Virgin Islands" were added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.

[3] See Act of September 21, 1959, 73 Stat. 574, p. 227.

[4] The language appearing after "(42 U.S.C. 1855)" was added by the Act of August 7, 1961, 75 Stat. 203, 204. It was further amended by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.

portation costs in making delivery of the commodity to designated agencies at one or more central locations in each State or other area.[5] * * * (7 U.S.C. 1427.)

ACT OF SEPTEMBER 21, 1959,[6] AS AMENDED

To authorize the sale at current support prices of agricultural commodities owned by the Commodity Credit Corporation to provide feed for livestock in areas determined to be emergency areas, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, notwithstanding the provisions of section 407 of the Agricultural Act of 1949, the Secretary of Agriculture is authorized to sell, at not less than the current basic county support rate including the value of any applicable price support payment in kind (or a comparable price if there is no current basic county support rate),[7] any wheat, corn, oats, barley, rye, or grain sorghums (hereafter referred to as feed grains), owned by the Commodity Credit Corporation, to provide feed for livestock in any area determined by him to be an emergency area under section 2.

SEC. 2.[8] The Secretary may, after certification by the Governor of the State in which such area is situated of the need therefor, designate any area as an emergency area for the purposes of this Act if he determines that, as a result of flood, drought, hurricane, tornado, earthquake, or other catastrophe including disease or insect infestation, there is a shortage of feed for livestock in such area. "State" means any State in the United States, Puerto Rico, and the Virgin Islands.

SEC. 3.[8] The Secretary shall not sell feed grains under this Act to any person unless he is satisfied that such person does not have, and is unable to obtain through normal channels of trade without undue financial hardship, sufficient feed for livestock owned by him, and unless such person agrees to use the feed grains only for feed for such livestock. The Secretary may provide for the furnishing of feed grains or mixed feed, in accordance with regulations prescribed by him, to any such person by a feed dealer under an arrangement whereby feed grains in the feed so furnished would be replaced with feed grains owned or controlled by the Corporation and sold to such person at a price determined as provided in section 1.

SEC. 4. Any person who fails to carry out an agreement entered into under section 3 with respect to any feed grains purchased or furnished [9] under this Act, or who disposes of any such feed grains other than by feeding to livestock owned by him, shall be subject to a penalty equal to but not in excess of the market value of the feed grains involved, to be recovered by the Secretary in a civil suit brought for

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[5] The two preceding sentences were added by sec. 301 of the Agricultural Trade Development and Assistance Act of 1954, 68 Stat. 458. The words "or other area" were added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.

[6] 73 Stat. 574.

[7] The preceding phrase beginning with "at not less" was added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.

[8] The last sentence in secs. 3 and 4 were added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.

[9] The words "or furnished" were added by Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.

that purpose, and in addition shall be guilty of a misdemeanor and upon conviction thereof shall be subject to a fine of not more than $1,000 or imprisonment for not more than one year. (7 U.S.C. 1427 note.)

ACT OF SEPTEMBER 7, 1957

To authorize Commodity Credit Corporation to grant relief with respect to claims arising out of deliveries of eligible surplus feed grains on ineligible dates in connection with purchase orders under its emergency feed program.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Commodity Credit Corporation, under such regulations as may be approved by the Secretary of Agriculture, is hereby authorized to grant relief to farmers and dealers in connection with claims arising out of early and late deliveries under purchase orders for drought relief feed issued under the 1954, 1955, and 1956 emergency feed programs, by recognizing as valid those purchases and deliveries of designated surplus feed grains and approved mixed feeds, which (a) were actually purchased by the farmer from the dealer on or after the date the Secretary declared the county, where the purchase order was issued, to be eligible for assistance under the emergency feed program, and (b) are found to have been physically delivered to the farmer not later than six months from the expiration date of the purchase order issued to the farmer. (71 Stat. 632, 12 U.S.C. 1148a–2.)

Agricultural Act of 1949, as amended.—SEC. 421. Any person who disposes of any feed which has been made available to him under section 407 of this Act for use in relieving distress or for preservation and maintenance of foundation herds, other than as authorized by the Secretary, shall be subject to a penalty equal to the market value of the feed involved, to be recovered by the Secretary in a civil suit brought for that purpose, and in addition shall be guilty of a misdemeanor and upon conviction thereof shall be subject to a fine of not more than $1,000 or imprisonment for not more than one year. (Pub. L. 88–585, 78 Stat. 927, approved September 11, 1964.)

ECONOMIC OPPORTUNITY ACT OF 1964
PUBLIC LAW 88–452

August 20, 1964

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TITLE III—SPECIAL PROGRAMS TO COMBAT POVERTY IN RURAL AREAS

* * * * * * *

PART D—INDEMNITY PAYMENTS TO DAIRY FARMERS

SEC. 331. (a) The Secretary of Agriculture is authorized to make indemnity payments, at a fair market value, to dairy farmers who have been directed since January 1, 1964, to remove their milk from commercial markets because it contained residues of chemicals registered and approved for use by the Federal Government at the time of such use. Such indemnity payments shall continue to each dairy

farmer until he has been reinstated and is again allowed to dispose of his milk on commercial markets.

(b) There is hereby authorized to be appropriated such sums as may be necessary to carry out the purposes of this Act.

(c) The authority granted under this section shall expire on January 31, 1965.

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SUPPLEMENTAL APPROPRIATION ACT, 1965
PUBLIC LAW 88-635

October 7, 1964

Chapter VI

Executive Office of the President

Office of Economic Opportunity

ECONOMIC OPPORTUNITY PROGRAM

For expenses necessary to carry out the provisions of the Economic Opportunity Act of 1964 (Public Law 88-452 approved August 20, 1964), $800,000,000, of which * * * not more than $8,800,000 to carry out the purposes of part D of title III;

* * * * * * *

Provided further, That none of the funds contained in this Act shall be used to make indemnity payments, authorized by part D of title III, to any farmer whose milk was removed from commercial markets as a result of his failure to follow the procedures prescribed by the Federal Government for the use of the offending chemical:

* * * * * * *

PUBLIC LAW 85-58, JUNE 21, 1957

AN ACT

Making supplemental appropriations for the fiscal year ending June 30, 1957, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums are appropriated, out of any money in the Treasury not otherwise appropriated, to supply supplemental appropriations (this Act may be cited as the "Third Supplemental Appropriation Act, 1957") for the fiscal year ending June 30, 1957, and for other purposes, namely:

CHAPTER I
DEPARTMENT OF AGRICULTURE

* * * * * * *

Agricultural Conservation Program Service

EMERGENCY CONSERVATION MEASURES

For an additional amount to enable the Secretary to make payments to farmers who carry out emergency measures to control wind

erosion on farmlands or to rehabilitate farmlands damaged by wind erosion, floods, hurricanes, or other natural disasters when, as a result of the foregoing, new conservation problems have been created which, (1) if not treated, will impair or endanger the land, (2) materially affect the productive capacity of the land, (3) represent damage which is unusual in character and, except for wind erosion, is not the type which would recur frequently in the same area, and (4) will be so costly to rehabilitate that Federal assistance is or will be required to return the land to productive agricultural use, and for reimbursement to the appropriation to the President for "Disaster relief", for allocations to the Secretary of Agriculture for such purposes, $4,000,000,[10] to remain available through June 30, 1958 [10]: *Provided*, That this appropriation may be expended without regard to the adjustments required under section 8(e) of the Soil Conservation and Domestic Allotment Act, as amended (16 U.S.C. 590h), and may be distributed among States and individual farmers without regard to other provisions of law.

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[10] The Supplemental Appropriation Act, 1958, Pub. L. 85–170, 70 Stat. 426, approved August 28, 1957, appropriated an additional $20,000,000 to be used for the same purposes and subject to the same conditions as the funds appropriated in the Third Supplemental Appropriation Act, 1957.

The Supplemental Appropriation Act, 1959, Pub. L. 85–776, 72 Stat. 865, approved August 27, 1958, provided that the unobligated balance of the amounts made available in the Third Supplemental Appropriation Act, 1957, and in the Supplemental Appropriation Act, 1958, shall remain available until expended.

The Supplemental Appropriation Act, 1962, Pub. L. 87–332, 75 Stat. 733, approved September 30, 1961, appropriated an additional $5,000,000 to remain available until expended.

The Deficiency Appropriation Act, 1964, Pub. L. 88–317, 78 Stat. 204, approved June 9, 1964, appropriated an additional $4,000,000 to remain available until expended.

The Department of Agriculture and Related Agencies Appropriation Act, 1965, Pub. L. 88–573, 78 Stat. 862, approved September 2, 1964, appropriated an additional $4,000,000 with which shall be merged the unexpended balances of funds heretofore appropriated.

SUBPART H—GRAIN FOR WILDFOWL

ACT OF JULY 3, 1956[1]

AN ACT

To authorize the Secretary of the Interior to cooperate with Federal and non-Federal agencies in the prevention of waterfowl depredations, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, for the purpose of preventing crop damage by migratory waterfowl, the Commodity Credit Corporation shall make available to the Secretary of the Interior such wheat, corn, or other grains, acquired through price support operations and certified by the Commodity Credit Corporation to be available for the purposes of this Act or in such condition through spoilage or deterioration as not to be desirable for human consumption, as the Secretary of the Interior shall requisition pursuant to section 2 hereof. With respect to any grain thus made available, the Commodity Credit Corporation may pay packaging, transporting, handling, and other charges up to the time of delivery to one or more designated locations in each State. (7 U.S.C. 442.)

SEC. 2. Upon a finding by the Secretary of the Interior that any area in the United States is threatened with damage to farmers' crops by migratory waterfowl, whether or not during the open season for such migratory waterfowl, the Secretary of the Interior is hereby authorized and directed to requisition from the Commodity Credit Corporation and to make available to Federal, State, or local governmental bodies or officials, or to private organizations or persons, such grain acquired by the Commodity Credit Corporation through price-support operations in such quantities and subject to such regulations as the Secretary determines will most effectively lure migratory waterfowl away from crop depredations and at the same time not expose such migratory waterfowl to shooting over areas to which the waterfowl have been lured by such feeding programs. (7 U.S.C. 443.)

SEC. 3. With respect to all grain made available pursuant to section 2, the Commodity Credit Corporation shall be reimbursed by the Secretary of the Interior for its expenses in packaging and transporting such grain for purposes of this Act. (7 U.S.C. 444.)

SEC. 4. There are hereby authorized to be appropriated such sums as may be necessary to reimburse the Commodity Credit Corporation for its investment in the grain transferred pursuant to this Act. (7 U.S.C. 445.)

SEC. 5.[2] * * *

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[1] 70 Stat. 492.

[2] Sec. 5 providing for expiration of this Act 3 years after its enactment was repealed by the Act of August 4, 1959, 73 Stat. 279.

ACT OF AUGUST 17, 1961[3]

AN ACT

To authorize the use of Commodity Credit Corporation owned surplus grain by the States for emergency use in the feeding of resident game birds and other resident wildlife; to authorize the use of such surplus grain by the Secretary of the Interior for emergency use in the feeding of migratory birds, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That for the purpose of meeting emergency situations caused by adverse weather conditions or other factors destructive of important wildlife resources, the States are hereby authorized, upon the request of the State fish and game authority or other State agency having similar authority and a finding by the Secretary of the Interior that any area of the United States is threatened with serious damage or loss to resident game birds and other resident wildlife from starvation, to requisition from the Commodity Credit Corporation grain acquired by the Corporation through price support operations. Such grain may thereafter be furnished to the particular State for direct and sole utilization by the appropriate State agencies for purposes of this Act in such quantities as mutually agreed upon by the State and the Commodity Credit Corporation and subject to such regulations as may be considered desirable by the Corporation. The Corporation shall be reimbursed by the particular State in each instance for the expense of the Corporation in packaging and transporting such grain for purposes of this Act. (7 U.S.C. 447.)

SEC. 2. Upon a finding by the Secretary of the Interior that migratory birds are threatened with starvation in any area of the United States, the Secretary is authorized to requisition from the Commodity Credit Corporation grain acquired by that Corporation through price-support operations in such quantities as may be mutually agreed upon. The Corporation shall be reimbursed by the Secretary for its expense in packaging and transporting of such grain for purposes of this Act. (7 U.S.C. 448.)

SEC. 3. There are hereby authorized to be appropriated such sums as may be necessary to reimburse the Commodity Credit Corporation for its investment in grain transferred pursuant to this Act. (7 U.S.C. 449.)

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[3] 75 Stat. 389.

SUBPART I—GENERAL FISCAL STATUTES

ACT OF MARCH 8, 1938,[1] AS AMENDED

AN ACT

To maintain unimpaired the capital of the Commodity Credit Corporation at $100,000,000, and for other purposes.

SEC. 1.[2] * * *

SEC. 2.[2] * * *

[Public Law 87–155 [3]

AN ACT

To authorize annual appropriation to reimburse Commodity Credit Corporation for net realized losses sustained during any fiscal year in lieu of annual appropriations to restore capital impairment based on annual Treasury appraisals, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That sections 1 and 2 of the Act of March 8, 1938, as amended (15 U.S.C. 713a–1, 2), are hereby repealed.

SEC. 2. There is hereby authorized to be appropriated annually for each fiscal year, commencing with the fiscal year ending June 30, 1961, out of any money in the Treasury not otherwise appropriated, an amount sufficient to reimburse Commodity Credit Corporation for its net realized loss incurred during such fiscal year, as reflected in its accounts and shown in its report of its financial condition as of the close of such fiscal year. Reimbursement of net realized loss shall be with appropriated funds, as provided herein, rather than through the cancellation of notes. (15 U.S.C. Supp. 713a–11.)

SEC. 3. In the event the accounts of the Commodity Credit Corporation reflect a net realized gain for any such fiscal year, the amount of such net realized gain shall be deposited in the Treasury by the Commodity Credit Corporation and shall be credited to miscellaneous receipts. (15 U.S.C. Supp. 713a–12.)]

SEC. 3. [This section provided for the transfer of stock of the Delaware corporation to the United States.]

BORROWING POWER

SEC. 4. With the approval of the Secretary of the Treasury, the Commodity Credit Corporation is authorized to issue and have outstanding at any one time, bonds, notes, debentures, and other similar obligations in an aggregate amount not exceeding $14,500,000,000.[4]

[1] 52 Stat. 107, 15 U.S.C. 713a–1, et seq.
[2] Sections 1 and 2 repealed by Pub. L. 87–155, 75 Stat. 391, August 17, 1961.
[3] 75 Stat. 391, August 17, 1961, 15 U.S.C. 713a–11, 713a–12.
[4] This amount has been increased a number of times and was increased from $12,000,000,000 by the Act of August 1, 1956, 70 Stat. 783. See also sec. 4(i) of the Commodity Credit Corporation Charter Act (p. 138) and the Government Corporation Control Act (31 U.S.C. 841).

Such obligations shall be in such forms and denominations, shall have such maturities, shall bear such rates of interest, shall be subject to such terms and conditions, and shall be issued in such manner and sold at such prices as may be prescribed by the Commodity Credit Corporation, with the approval of the Secretary of the Treasury. Such obligations shall be fully and unconditionally guaranteed both as to interest and principal by the United States, and such guaranty shall be expressed on the face thereof, and such obligations shall be lawful investments and may be accepted as security for all fiduciary, trust, and public funds the investment or deposit of which shall be under the authority or control of the United States or any officer or officers thereof. In the event that the Commodity Credit Corporation shall be unable to pay upon demand, when due, the principal of, or interest on, such obligations, the Secretary of the Treasury shall pay to the holder the amount thereof which is hereby authorized to be appropriated, out of any money in the Treasury not otherwise appropriated, and thereupon to the extent of the amount so paid the Secretary of the Treasury shall succeed to all the rights of the holders of such obligations. The Secretary of the Treasury, in his discretion, is authorized to purchase any obligations of the Commodity Credit Corporation issued hereunder, and for such purpose the Secretary of the Treasury is authorized to use as a public-debt transaction the proceeds from the sale of any securities hereafter issued under the Second Liberty Bond Act, as amended, and the purposes for which securities may be issued under such Act, as amended, are extended to include any purchases of the Commodity Credit Corporation's obligations hereunder. The Secretary of the Treasury may at any time sell any of the obligations of the Commodity Credit Corporation acquired by him under this section. All redemptions, purchases, and sales by the Secretary of the Treasury of the obligations of the Commodity Credit Corporation shall be treated as public-debt transactions of the United States. No such obligations shall be issued in excess of the assets of the Commodity Credit Corporation, including the assets to be obtained from the proceeds of such obligations, but a failure to comply with this provision shall not invalidate the obligations or the guaranty of the same: *Provided*, That this sentence shall not limit the authority of the Corporation to issue obligations for the purpose of carrying out its annual budget programs submitted to and approved by the Congress pursuant to the Government Corporation Control Act (31 U.S.C., 1946 edition, sec. 841).[5] The Commodity Credit Corporation shall have power to purchase such obligations in the open market at any time and at any price. (15 U.S.C. 713a–4.)

TAXATION

SEC. 5. Bonds, notes, debentures, and other similar obligations issued by the Commodity Credit Corporation under the provisions of this Act shall be deemed and held to be instrumentalities of the Government of the United States, and as such they and the income derived therefrom shall be exempt from Federal, State, municipal,

[5] Proviso added by sec. 410 of the Agricultural Act of 1949, 63 Stat. 1057.

and local taxation (except surtaxes, estate, inheritance, and gift taxes). The Commodity Credit Corporation, including its franchise, its capital, reserves, and surplus, and its income shall be exempt from all taxation now or hereafter imposed by the United States, by any Territory, dependency, or possession thereof, or by any State, county, municipality, or local taxing authority; except that any real property of the Commodity Credit Corporation shall be subject to State, Territorial, county, municipal, or local taxation to the same extent according to its value as other real property is taxed. (15 U.S.C. 713a–5.) [6]

FEDERAL RESERVE BANKS AS FISCAL AGENTS

Act of July 16, 1943—Sec. 3. The Federal Reserve Banks are hereby authorized to act as depositaries, custodians, and fiscal agents for the Commodity Credit Corporation. (57 Stat. 566; 12 U.S.C. 395.)

ADMINISTRATIVE EXPENSE LIMITATION

[See the Commodity Credit Corporation item in the Department of Agriculture and Farm Credit Administration Appropriation Act, 1965, in Part VIII hereof, and the similar items in previous appropriation acts. Section 104 of the Government Corporation Control Act (approved Dec. 6, 1945, 59 Stat. 597; 31 U.S.C. 841) provides for enactment of necessary appropriations making available corporate funds of each wholly owned Government corporation for administrative expenses or limiting the use thereof.]

REIMBURSEMENT BY OTHER AGENCIES

Act of July 16, 1943—Sec. 4. Full reimbursement shall be made to the Commodity Credit Corporation for services performed, losses sustained, operating costs incurred, or commodities purchased or delivered to or on behalf of the Lend-Lease Administration, the Army or Navy, the Board of Economic Warfare, the Reconstruction Finance Corporation, or any other Government agency, from the appropriate funds of these agencies. (57 Stat. 566; 15 U.S.C. 713a–9.)

REIMBURSEMENT OF PROCUREMENT COSTS

Department of Agriculture Organic Act of 1944—Sec. 402. Applicable appropriations available to the War Food Administration [7] current at the time services are rendered or payment therefor is received may be reimbursed by nongovernmental agencies or foreign governments (by advance credits or reimbursements) for the actual or estimated costs, as determined by the War Food Administration, incident to procuring agricultural commodities for such nongovermental agencies or foreign governments. (Sept. 21, 1944, 58 Stat. 734, 738; 5 U.S.C. 569.)

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[6] See Act of February 19, 1941, 55 Stat. 7, 9, as amended March 28, 1942, 56 Stat. 189, 190, 31 U.S.C. sec. 742a, abolishing tax exemption for income from obligations issued or guaranteed by the United States or any agency or instrumentality thereof.

[7] The War Food Administration was terminated by Executive Order No. 9577, and its functions transferred to the Secretary of Agriculture (E.O. 9577, June 29, 1945, 10 F.R. 8087).

CROP INSURANCE AND CONSERVATION MATERIALS

The Agricultural Adjustment Act of 1938—Sec. 391(c). [This section (p. 113) contains authority for loans by Commodity Credit Corporation to the Secretary of Agriculture during each fiscal year of such sums, not to exceed $50,000,000, as he estimates will be required to make crop insurance premium advances and to make advances for the purchase of conservation materials from January 1 to June 30 of each year, with repayment (plus interest) to be made from appropriated funds. (7 U.S.C. 1391(c)).]

COST OF CLASSING OR GRADING

Department of Agriculture Appropriation Act, 1950—* * * On and after June 29, 1949, appropriations available for classing or grading any agricultural commodity without charge to the producers thereof may be reimbursed from nonadministrative funds of the Commodity Credit Corporation for the cost of classing or grading any such commodity for producers who obtain Commodity Credit Corporation price support. (June 29, 1949, 63 Stat. 324, 344, 7 U.S.C. 440.)

Department of Agriculture Appropriation Act, 1952—* * * Hereafter there may be transferred to appropriations available for classing or grading any agricultural commodity without charge to the producers thereof such sums from nonadministrative funds of the Commodity Credit Corporation as may be necessary in addition to other funds available for these purposes, such transfers to be reimbursed from subsequent appropriations therefor. (Aug. 31, 1951, 65 Stat. 225, 239; 7 U.S.C. 414a.)

SUBPART J. MISCELLANEOUS COMMODITY CREDIT CORPORATION STATUTES

EXEMPTION FROM FEDERAL PROPERTY AND ADMINISTRATIVE SERVICES ACT

Act of June 30, 1949, as amended—Sec. 602. * * * Nothing in this Act shall impair or affect any authority of—* * * (2) any executive agency with respect to any phase (including, but not limited to, procurement, storage, transportation, processing, and disposal) of any program conducted for purposes of resale, price support, grants to farmers, stabilization, transfer to foreign governments, or foreign aid, relief, or rehabilitation: *Provided*, That the agency carrying out such program shall, to the maximum extent practicable, consistent with the fulfillment of the purposes of the program and the effective and efficient conduct of its business, coordinate its operations with the requirements of said chapters and the policies and regulations prescribed pursuant thereto; * * *. (June 30, 1949, 63 Stat. 377, 401; Sept. 5, 1950, 64 Stat. 578, 583; 40 U.S.C. 474.)

TREATMENT OF COMMODITY CREDIT LOANS FOR INCOME TAX PURPOSES

INTERNAL REVENUE CODE OF 1954[1]

SEC. 77. COMMODITY CREDIT LOANS

(a) ELECTION TO INCLUDE LOANS IN INCOME.—Amounts received as loans from the Commodity Credit Corporation shall, at the election of the taxpayer, be considered as income and shall be included in gross income for the taxable year in which received.

(b) EFFECT OF ELECTION ON ADJUSTMENTS FOR SUBSEQUENT YEARS.—If a taxpayer exercises the election provided for in subsection (a) for any taxable year, then the method of computing income so adopted shall be adhered to with respect to all subsequent taxable years unless with the approval of the Secretary or his delegate a change to a different method is authorized. (26 U.S.C. 77.)

SEC. 1016. ADJUSTMENTS TO BASIS.

(a) GENERAL RULE.—Proper adjustment in respect of the property shall in all cases be made—

* * * * * * *

(8) in the case of property pledged to the Commodity Credit Corporation, to the extent of the amount received as a loan from the Commodity Credit Corporation and treated by the taxpayer as income for the year in which received pursuant to section 77, and to the extent of any deficiency on such loan with respect to which the taxpayer has been relieved from liability; * * * (26 U.S.C. 1016.)

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[1] These provisions of the Internal Revenue Code are derived from the Act of June 29, 1939, 53 Stat. 862, 879, and the Act of October 21, 1942, 56 Stat. 798, 848.

INSURANCE OF COTTON AND RECONCENTRATION OF COTTON

[See section 383 of the Agricultural Adjustment Act of 1938 (7 U.S.C. 1383(a)) and the Act of June 16, 1938 (7 U.S.C. 1383a) pp. 110 and 111.]

STIMULATION OF FOREIGN PRODUCTION

Taft Anti-Inflation Law—Sec. 7. Notwithstanding any other provision of law, in order to alleviate and prevent shortages in foods, agricultural commodities, and products thereof, Commodity Credit Corporation is authorized to carry out projects to stimulate and increase the production of foods, agricultural commodities and products thereof, in non-European foreign countries. Such projects may include procurement, the making of advances and price guaranties, the furnishing of technical information and assistance, the furnishing of seed, fertilizer, machinery, equipment, and other materials, and such other actions as are necessary or incident to the carrying out of such projects: *Provided*, That any such program is first submitted to Congress by the Secretary of Agriculture, and is not disapproved by concurrent resolution of Congress within sixty days thereafter. (Dec. 30, 1947, 61 Stat. 945, 947; 50 U.S.C. App. 1917.)

OTHER PRINCIPAL STATUTES HAVING APPLICABILITY TO COMMODITY CREDIT CORPORATION

Government Corporation Control Act (Dec. 6, 1945, 59 Stat. 597; 31 U.S.C. 841.)

Sections 222 and 1026 of the U.S. Criminal Code (June 25, 1948, 62 Stat. 683, 696, 755; 18 U.S.C. 222, 1026) providing penalties for acceptance of fees in connection with cancellation of farm indebtedness.

Section 206 of the Technical Changes Act of 1953 (August 15, 1953, 67 Stat. 615, 620; 26 U.S.C. 169) providing for amortization deductions for grain storage facilities. [Regulations were issued under this section by the Commissioner of Internal Revenue on Nov. 15, 1954, and were published in the Federal Register on Nov. 19, 1954. 19 F.R. 7453.]

Act of June 11, 1947, as amended (61 Stat. 308; 71 Stat. 464; 31 U.S.C. 132), requiring withdrawal of the amount of all checks, which have not been paid prior to the close of the fiscal year next following the fiscal year in which issued, from the account of designated depositories and deposit of the amount with the Treasurer of the United States for credit to a consolidated account.

Section 9(c) of the Act of August 2, 1946 (41 U.S.C. 5), providing that the bid procedure set out in section 3709, Revised Statutes, as amended (41 U.S.C. 5), shall apply only to the administrative transactions of wholly-owned Government corporations.

Independent Offices Appropriation Act, 1950 (Aug. 24, 1949, 63 Stat. 631, 662; 31 U.S.C. 870), authorizing corporations subject to the Government Corporation Control Act to consolidate into one or more accounts for banking and checking purposes all cash, including amounts appropriated, from whatever source derived.

Secs. 207 and 209 of Title II—General Provisions of the General Government Matters Appropriation Act, 1959. (72 Stat. 225, 40 U.S.C. 33a, 31 U.S.C. 724.)

Small Business Act, as amended (15 U.S.C. 631 et. seq.).

Civil Rights Act of 1964 (July 2, 1964, 78 Stat. 241.)

Sec. 286b(b)(3) of Title 22, U.S.C. provides that the National Advisory Council on International Monetary and Financial Problems shall be consulted by Government agencies in the making of foreign loans or in engaging in foreign financial, exchange or monetary transactions.

FEDERAL CROP INSURANCE ACT, AS AMENDED

EXPLANATORY NOTE

The Federal Crop Insurance Act, which was enacted as title V of the Agricultural Adjustment Act of 1938 (52 Stat. 72), established the Federal Crop Insurance Corporation to insure producers of wheat against unavoidable losses in production resulting from adverse weather conditions, disease, insect infestation and other hazards. In 1941, the Act was amended to authorize the Corporation to insure cotton as well as wheat (55 Stat. 255). The Congress did not provide funds for insurance on crops harvested in 1944 but in December 1944, the insurance program was reinstated as to wheat and cotton and extended to permit the insuring of flax on a national basis and other commodities on an experimental basis (58 Stat. 918). In 1947, the Congress made a number of basic changes in the nature and scope of the crop insurance program the more important of which (1) placed crop insurance entirely on an experimental basis by restricting the number of commodities for which the Corporation could write insurance and the number of counties in which insurance could be offered; and (2) limited the level of insurance that could be provided to the general cost of producing the insured crop (61 Stat. 718). The Act was again amended in 1949 to permit the Corporation to expand through 1953 and to operate more efficiently the experimental program initiated by the 1947 legislation (63 Stat. 663). A 1953 amendment permits continued expansion by authorizing insurance in 100 additional counties each year (67 Stat. 575); however in 1964, the number of counties was increased to 150 counties by Pub. L. 88–589 (78 Stat. 933). The Act of August 3, 1956, 70 Stat. 1034, authorized the Corporation to consider certain costs as non-administrative and to use premium income for administrative expenses within limits prescribed by applicable legislation. Pub. L. 85–111, 71 Stat. 309, July 23, 1957 added a new subsection (f) to section 508 to provide reinsurance in Puerto Rico under certain conditions. In 1959, the Federal Crop Insurance Act was further amended by the enactment of Pub. L. 86–131, 73 Stat. 278, approved August 4, 1959, which provided that insurance shall not be provided for any agricultural commodity in any county in which the Board determines that income therefrom is an unimportant part of the total agricultural income of the county.

PART V
FEDERAL CROP INSURANCE ACT, AS AMENDED [1]

SHORT TITLE AND APPLICATION OF OTHER PROVISIONS

SEC. 501. This title may be cited as the "Federal Crop Insurance Act". Except as otherwise expressly provided the provisions in titles I to IV, inclusive, shall not apply with respect to this title, and the term "Act" wherever it appears in such titles shall not be construed to include this title. (7 U.S.C. 1501.)

DECLARATION OF PURPOSE

SEC. 502. It is the purpose of this title to promote the national welfare by improving the economic stability of agriculture through a sound system of crop insurance and providing the means for the research and experience helpful in devising and establishing such insurance. (7 U.S.C. 1502.)

SEC. 503. To carry out the purposes of this title, there is hereby created as an agency of and within the Department of Agriculture a body corporate with the name "Federal Crop Insurance Corporation" (herein called the Corporation). The principal office of the Corporation shall be located in the District of Columbia, but there may be established agencies or branch offices elsewhere in the United States under rules and regulations prescribed by the Board of Directors. (7 U.S.C. 1503.)

CAPITAL STOCK

SEC. 504. (a) The Corporation shall have a capital stock of $100,000,000 subscribed by the United States of America, payment for which shall, with the approval of the Secretary of Agriculture, be subject to call in whole or in part by the Board of Directors of the Corporation. (7 U.S.C. 1504(a).)

(b) There is hereby authorized to be appropriated such sums as are necessary for the purpose of subscribing to the capital stock of the Corporation. (7 U.S.C. 1504(b).)

(c) Receipts for payments by the United States of America for or on account of such stock shall be issued by the Corporation to the Secretary of the Treasury and shall be evidence of the stock ownership by the United States of America. (7 U.S.C. 1504(c).)

MANAGEMENT OF CORPORATION

SEC. 505. (a) The management of the Corporation shall be vested in a Board of Directors (hereinafter called the "Board") subject to the general supervision of the Secretary of Agriculture. The Board shall consist of the manager of the Corporation, two other persons employed in the Department of Agriculture, and two persons experienced in the insurance business who are not otherwise employed by

[1] The Federal Crop Insurance Act was enacted as title V of the Agricultural Adjustment Act of 1938.

the Government. The Board shall be appointed by, and hold office at the pleasure of the Secretary of Agriculture, who shall not, himself, be a member of the Board. (7 U.S.C. 1505(a).)

(b) Vacancies in the Board so long as there shall be three members in office shall not impair the powers of the Board to execute the functions of the Corporation, and three of the members in office shall constitute a quorum for the transaction of the business of the Board. (7 U.S.C. 1505(b).)

(c) The Directors of the Corporation who are employed in the Department of Agriculture shall receive no additional compensation for their services as such Directors, but may be allowed necessary traveling and subsistence expenses when engaged in business of the Corporation, outside of the District of Columbia. The members of the Board who are not employed by the Government shall be paid such compensation for their services as directors as the Secretary of Agriculture shall determine, but such compensation shall not exceed $50 per day each when actually employed and transportation expenses plus not to exceed $10 per diem in lieu of subsistence expenses when on business of the Corporation away from their homes or regular places of business. (7 U.S.C. 1505 (c).)

(d) The manager of the Corporation shall be its chief executive officer, with such power and authority as may be conferred upon him by the Board. He shall be appointed by, and hold office at the pleasure of, the Secretary of Agriculture. (7 U.S.C. 1505(d).)

GENERAL POWERS

SEC. 506. The Corporation—

(a) shall have succession in its corporate name; (7 U.S.C. 1506(a).)

(b) may adopt, alter, and use a corporate seal, which shall be judicially noticed; (7 U.S.C. 1506(b))

(c) may make contracts and purchase or lease and hold such real and personal property as it deems necessary or convenient in the transaction of its business, and may dispose of such property held by it upon such terms as it deems appropriate; (7 U.S.C. 1506(c).)

(d) subject to the provisions of section 508(c), may sue and be sued in its corporate name in any court of record of a State having general jurisdiction, or in any United States district court, and jurisdiction is hereby conferred upon such district court to determine such controversies without regard to the amount of controversy: *Provided*, That no attachment, injunction, garnishment, or other similar process, mesne or final, shall be issued against the Corporation or its property; (7 U.S.C. 1506(d).)

(e) may adopt, amend, and repeal bylaws, rules, and regulations governing the manner in which its business may be conducted and the powers granted to it by law may be exercised and enjoyed; (7 U.S.C. 1506(e).)

(f) shall be entitled to the free use of the United States mails in the same manner as the other executive agencies of the Government; (7 U.S.C. 1506(f).)

(g) with the consent of any board, commission, independent establishment, or executive department of the Government, including any field service thereof, may avail itself of the use of information, serv-

ices, facilities, officials, and employees thereof in carrying out the provisions of this title; (7 U.S.C. 1506(g).)

(h) may conduct researches, surveys, and investigations relating to crop insurance and shall assemble data for the purpose of establishing sound actuarial bases for insurance on agricultural commodities; (7 U.S.C. 1506(h).)

(i) shall determine the character and necessity for its expenditures under this title and the manner in which they shall be incurred, allowed, and paid, without regard to the provisions of any other laws governing the expenditure of public funds and such determinations shall be final and conclusive upon all other officers of the Government; (7 U.S.C. 1506(i).)

(j) shall have such powers as may be necessary or appropriate for the exercise of the powers herein specifically conferred upon the Corporation and all such incidental powers as are customary in corporations generally. (7 U.S.C. 1506(j).)

PERSONNEL

SEC. 507. (a) The Secretary shall appoint such officers and employees as may be necessary for the transaction of the business of the Corporation pursuant to civil-service laws and regulations, fix their compensation in accordance with the provisions of the [Classification Act of 1949 (5 U.S.C. 1071–1153)], define their authority and duties, delegate to them such of the powers vested in the Corporation as he may determine, require bond of such of them as he may designate, and fix the penalties and pay the premiums of such bonds: *Provided*, That personnel paid by the hour, day, or month when actually employed, and county crop insurance committeemen may be appointed and their compensation fixed without regard to civil-service laws and regulations or the [Classification Act of 1949]. (7 U.S.C. 1507(a).)

(b) Insofar as applicable, the benefits of the Act entitled "An Act to provide compensation for employees of the United States suffering injuries while in the performance of their duties, and for other purposes," approved September 7, 1916, as amended, shall extend to persons given employment under the provisions of this title, including the employees of the committees and associations referred to in subsection (c) of this section and the members of such committees. (7 U.S.C. 1507(b).)

(c) The Board may establish or utilize committees or associations of producers in the administration of this title and make payments to such committees or associations to cover the estimated administrative expenses to be incurred by them in cooperating in carrying out this title and may provide that all or part of such estimated expenses may be included in the insurance premiums provided for in this title. (7 U.S.C. 1507(c).)

(d) The Secretary of Agriculture may allot to bureaus and offices of the Department of Agriculture or transfer to such other agencies of the Sate and Federal Governments as he may request to assist in carrying out this title any funds made available pursuant to the provisions of section 516 of this Act, except that employees or agencies responsible for administering this Act in each county shall be

selected and designated by the Corporation and shall be responsible directly to the Corporation without the intervention of any intermediate office or agency. (7 U.S.C. 1507(d).)

(e) In carrying out the provisions of this title the Board may, in its discretion, utilize producer-owned and producer-controlled cooperative associations. (7 U.S.C. 1507(e).)

CROP INSURANCE

SEC. 508.[2] To carry out the purposes of this title the Corporation is authorized and empowered—

(a) Commencing with crops planted for harvest in 1948, for the purpose of determining the most practical plan, terms, and conditions of insurance for agricultural commodities, if sufficient actuarial data are available, as determined by the Board, to insure, or to reinsure insurers of, producers of such agricultural commodities under any plan or plans of insurance determined by the Board to be adapted to any such commodity. Such insurance shall be against loss of the insured commodity due to unavoidable causes, including drought, flood, hail, wind, frost, winterkill, lightning, fire, excessive rain, snow, wildlife, hurricane, tornado, insect infestation, plant disease, and such other unavoidable causes as may be determined by the Board: *Provided*, That, except in the case of tobacco, such insurance shall not extend beyond the period the insured commodity is in the field. In 1948 insurance shall be limited to not more than seven agricultural commodities (including wheat, cotton, flax, corn, and tobacco) and to not more than three additional agricultural commodities in each year thereafter: *Provided*, That other agricultural commodities may be included in multiple crop insurance (insurance on two or more agricultural commodities under one contract with a producer). Beginning with crops planted for harvest in 1954, crop insurance may be offered each year in not to exceed 150 [3] counties in addition to the number of counties in which such insurance was offered in the preceding year. In determining the new counties in which such insurance is to be offered and the commodities to be insured, the Corporation shall take into consideration the demand of farmers for such insurance, the extent to which such insurance is available to commercial producers of insured commodities, and the anticipated risk of loss to the Corporation. Reinsurance for private insurance companies shall be limited to not to exceed twenty counties which may be selected without regard to the other county limitations specified herein. Any insurance offered against loss in yield shall not cover in excess of 75 per centum of the recorded or appraised average yield of the commodity on the insured farm for a representative period subject to such adjustments as the Board may prescribe to the end that the average yields fixed for farms in the same area, which are subject to the same conditions, may be fair and just: *Provided*, That if 75 per centum of the average yield represents generally more protection than the investment in the crop in any

[2] Amended by Pub. L. 86–131, 73 Stat. 278, approved August 4, 1959.
[3] The number of counties was increased from 100 to 150 counties by Pub. L. 88–589, 78 Stat. 934, approved September 12, 1964.

area, taking into consideration recognized farming practices, the Board shall reduce such maximum percentage so as more nearly to reflect the investment in the crop in such area. Insurance provided under this subsection shall not cover losses due to the neglect or malfeasance of the producer, or to the failure of the producer to reseed to the same crop in areas and under circumstances where it is customary to so reseed, or to the failure of the producer to follow established good farming practices. Counties selected by the Board shall be representative of the several areas where the agricultural commodity insured is normally produced. The Board may limit or refuse insurance in any county or area, or on any farm, on the basis of the insurance risk involved. Insurance shall not be provided on any agricultural commodity in any county in which the Board determines that the income from such commodity constitutes an unimportant part of the total agricultural income of the county, except that insurance may be provided for producers on farms situated in a local producing area bordering on a county with a crop-insurance program. The Corporation shall report annually to the Congress the results of its operations as to each commodity insured. (7 U.S.C. 1508(a).)

(b) To fix adequate premiums for insurance in the agricultural commodity or in cash, at such rates as the Board deems sufficient to cover claims for crop losses on such insurance and to establish as expeditiously as possible a reasonable reserve against unforseen losses: *Provided*, That such premiums may be established on the basis of the parity or comparable price for the commodity as determined and published by the Secretary of Agriculture, or on the basis of an average market price designated by the Board. Such premiums shall be collected at such time or times, or shall be secured in such manner, as the Board may determine. (7 U.S.C. 1508(b).)

(c) To adjust and pay claims for losses in the agricultural commodity or in cash, under rules prescribed by the Board: *Provided*, That indemnities may be determined on the same price basis as premiums are determined for the crop with respect to which such indemnities are paid. The Corporation shall provide for the posting annually in each county at the county courthouse of a list of indemnities paid for losses on farms in such county. In the event that any claim for indemnity under the provisions of this title is denied by the Corporation, an action on such claim may be brought against the Corporation in the United States district court, or in any court of record of the State having general jurisdiction, sitting in the district or county in which the insured farm is located, and jurisdiction is hereby conferred upon such district courts to determine such controversies without regard to the amount in controversy: *Provided*, That no suit on such claim shall be allowed under this section unless the same shall have been brought within one year after the date when notice of denial of the claim is mailed to and received by the claimant. (7 U.S.C. 1508(c).)

(d) From time to time, in such manner and through such agencies as the Board may determine, to purchase, handle, store, insure, provide storage facilities for, and sell the agricultural commodity, and pay any expenses incidental thereto, it being the intent of this pro-

vision, however, that, insofar as practicable, the Corporation shall purchase the agricultural commodity only at the rate and to a total amount equal to the payment of premiums in cash by farmers or to replace promptly the agricultural commodity sold to prevent deterioration; and shall sell the agricultural commodity only to the extent necessary to cover payments of indemnities and to prevent deterioration: *Provided, however*, That nothing in this section shall prevent prompt offset purchases and sales of the agricultural commodity for convenience in handling. Nothing in this section shall prevent the Corporation from accepting, for the payment of premiums, notes payable in the commodity insured, or the cash equivalent, upon such security as may be determined pursuant to subsection (b) of this section, and from purchasing the quantity of the commodity represented by any of such notes not paid at maturity. The restriction on the purchase and sale of the agricultural commodity provided in this section shall be made a part of any crop insurance agreement made under this title. Notwithstanding any provision of this title, there shall be no limitation upon the legal or equitable remedies available to the insured to enforce against the Corporation the foregoing restriction with respect to purchases and sales of the agricultural commodity. (7 U.S.C. 1508(d).)

(e) In connection with insurance upon yields of cotton, to include provision for additional premium and indemnity in terms of lint cotton to cover loss of cottonseed, such additional premium and indemnity to be determined on the basis of the average relationship between returns from cottonseed and returns from lint cotton for the same period of years as that used for computing yields and premium rates. (7 U.S.C. 1508(e).)

(f) [4] Notwithstanding any other provision of this title, the corporation is hereby authorized, under such terms and conditions as it deems consistent with sound reinsurance principles, to provide reinsurance on any crop or plantation insurance provided in Puerto Rico by a duly authorized agency of the Commonwealth of Puerto Rico: *Provided*, That, no application for reinsurance authorized herein shall be approved, unless the corporation shall have determined that the reinsurance deemed necessary is not available from recognized private sources at reasonable cost. (7 U.S.C. 1508(f).)

INDEMNITIES EXEMPT FROM LEVY

SEC. 509. Claims for indemnities under this title shall not be liable to attachment, levy, garnishment, or any other legal process before payment to the insured or to deduction on account of the indebtedness of the insured or his estate to the United States except claims of the United States or the Corporation arising under this title. (7 U.S.C. 1509.)

DEPOSIT OF FUNDS

SEC. 510. All money of the Corporation not otherwise employed may be deposited with the Treasurer of the United States or in any bank approved by the Secretary of the Treasury, subject to withdrawal by the Corporation at any time, or with the approval of the

[4] Subsection (f) added by Pub. L. 85–111, 71 Stat. 309, July 23, 1957.

Secretary of the Treasury may be invested in obligations of the United States or in obligations guaranteed as to principal and interest by the United States. Subject to the approval of the Secretary of the Treasury, the Federal Reserve banks are hereby authorized and directed to act as depositories, custodians, and fiscal agents for the Corporation in the performance of its powers conferred by this title. (7 U.S.C. 1510.)

TAX EXEMPTIONS

SEC. 511. The Corporation, including its franchise, its capital, reserves, and surplus, and its income and property, shall be exempt from all taxation now or hereafter imposed by the United States or by any Territory, dependency, or possession thereof, or by any State, county, municipality or local taxing authority. (7 U.S.C. 1511.)

FISCAL AGENT OF GOVERNMENT

SEC. 512. When designated for that purpose by the Secretary of the Treasury, the Corporation shall be a depository of public money, except receipts from customs, under such regulations as may be prescribed by said Secretary; and it may also be employed as a financial agent of the Government; and it shall perform all such reasonable duties, as a depository of public money and financial agent of the Government, as may be required of it. (7 U.S.C. 1512.)

ACCOUNTING BY CORPORATION

SEC. 513. The Corporation shall at all times maintain complete and accurate books of account and shall file annually with the Secretary of Agriculture a complete report as to the business of the Corporation. The financial transactions of the Corporation shall be audited at least once each year by the General Accounting Office for the sole purpose of making a report to Congress, together with such recommendations as the Comptroller General of the United States may deem advisable: *Provided*, That such report shall not be made until the Corporation shall have had reasonable opportunity to examine the exceptions and criticisms of the Comptroller General or the General Accounting Office, to point out errors therein, explain or answer the same, and to file a statement which shall be submitted by the Comptroller General with his report. (7 U.S.C. 1513.)

CRIMES AND OFFENSES

SEC. 514. (Subsections (a) through (e) repealed by 62 Stat. 859.)
(See criminal provisions beginning on p. 259.)

(f) The provisions of section 22 of Title 41 shall not apply to any crop insurance agreements made under this title. (7 U.S.C. 1514(f).)

ADVISORY COMMITTEE

SEC. 515. The Secretary of Agriculture is authorized to appoint from time to time an advisory committee, consisting of not more than five members experienced in agricultural pursuits and appointed with due consideration to their geographical distribution, to advise the Corporation with respect to carrying out the purposes of this title. The compensation of the members of such committee shall be deter-

mined by the Board but shall not exceed $10 per day each while actually employed and actual necessary traveling and subsistence expenses, or a per diem allowance in lieu thereof. (7 U.S.C. 1515.)

APPROPRIATIONS AND REGULATIONS

SEC. 516. (a) There are hereby authorized to be appropriated such sums, not in excess of $12,000,000 for each fiscal year beginning after June 30, 1938, as may be necessary to cover the operating and administrative costs of the Corporation, which shall be allotted to the Corporation in such amounts and at such time or times as the Secretary of Agriculture may determine: *Provided*, That expenses in connection with the purchase, transportation, handling, or sale of the agricultural commodity and the direct cost of loss adjusters for crop inspections and loss adjustments may be considered by the Corporation as being non-administrative or non-operating expenses. The Corporation is authorized to use premium income for administrative and operating costs within limits prescribed in applicable appropriationes. (7 U.S.C. 1516(a).)

(b) The Secretary and the Corporation, respectively, are authorized to issue such regulations as may be necessary to carry out the provisions of this title. (7 U.S.C. 1516(b).)

SEPARABILITY

SEC. 517. The section of this title and subdivisions of sections are hereby declared to be separable, and in the event any one or more sections or parts of the same of this title be held to be unconstitutional, the same shall not affect the validity of other sections or parts of sections of this title. (7 U.S.C. 1517.)

SEC. 518. "Agricultural commodity", as used in this title, means wheat, cotton, flax, corn, dry beans, oats, barley, rye, tobacco, rice, peanuts, soybeans, sugar beets, sugarcane, timber and forests, potatoes and other vegetables, citrus and other fruits, tame hay, or any other agricultural commodity determined by the Board pursuant to subsection (a) of section 508 of this title, or any one or more of such commodities, as the context may indicate. (7 U.S.C. 1518.)

RIGHT TO AMEND

SEC. 519. The right to alter, amend, or repeal this title is hereby reserved. (7 U.S.C. 1519.)

CRIMINAL PROVISIONS APPLICABLE TO FEDERAL CROP INSURANCE CORPORATION

Whoever, being an officer, agent or employee of or connected in any capacity with the Reconstruction Finance Corporation, Federal Deposit Insurance Corporation, Home Owners' Loan Corporation, Farm Credit Administration, Federal Housing Administration, Federal Farm Mortgage Corporation, Federal Crop Insurance Corporation, Farmers' Home Corporation or any land bank, intermediate credit bank, bank for cooperatives or any lending, mortgage, insurance, credit or savings and loan corporation or association authorized or acting under the laws of the United States, and whoever, being a receiver of any such institution, or agent or employee of the re-

ceiver, embezzles, abstracts, purloins or willfully misapplies any moneys, funds, credits, securities or other things of value belonging to such institution, or pledged or otherwise intrusted to its care, shall be fined not more than $5,000 or imprisoned not more than five years, or both; but if the amount or value embezzled, abstracted, purloined or misapplied does not exceed $100, he shall be fined not more than $1,000 or imprisoned not more than one year, or both. (18 U.S.C. 657.)

Whoever, with intent to defraud, knowingly conceals, removes, disposes of, or converts to his own use or to that of another any property mortgaged or pledged to, or held by, the Farm Credit Administration, any Federal intermediate credit bank, or the Federal Farm Mortgage Corporation, Federal Crop Insurance Corporation, Farmers' Home Corporation, or any production credit corporation or corporation in which a production credit corporation holds stock, any regional agricultural credit corporation, or any bank for cooperatives, shall be fined not more than $5,000 or imprisoned not more than five years, or both; but if the value of such property does not exceed $100, he shall be fined not more than $1,000 or imprisoned not more than one year, or both. (18 U.S.C. 658.)

Whoever, being an officer, agent or employee of or connected in any capacity with the Reconstruction Finance Corporation, Federal Deposit Insurance Corporation, Home Owners' Loan Corporation, Farm Credit Administration, Federal Housing Administration, Federal Farm Mortgage Corporation, Federal Crop Insurance Corporation, Farmers' Home Corporation, or any land bank, intermediate credit bank, bank for cooperatives or any lending, mortgage, insurance, credit or savings and loan corporation or association authorized or acting under the laws of the United States, with intent to defraud any such institution or any other company, body politic or corporate, or any individual, or to deceive any officer, auditor, examiner or agent of any such institution or of department or agency of the United States, makes any false entry in any book, report or statement of or to any such institution, or without being duly authorized, draws any order or bill of exchange, makes any acceptance, or issues, puts forth or assigns any note, debenture, bond or other obligation, or draft, bill of exchange, mortgage, judgment, or decree, or, with intent to defraud the United States or any agency thereof, or any corporation, institution, or association referred to in this section, participates or shares in or receives directly or indirectly any money, profit, property, or benefits through any transaction, loan, commission, contract, or any other act of any such corporation, institution, or association, shall be fined not more than $10,000 or imprisoned not more than five years, or both. (18 U.S.C. 1006.)

Whoever knowingly makes any false statement or report, or willfully overvalues any land, property or security, for the purpose of influencing in any way the action of the Reconstruction Finance Corporation, Farm Credit Administration, Federal Crop Insurance Corporation, Farmers' Home Corporation, any Federal intermediate credit bank, or the Federal Farm Mortgage Corporation, or any division, officer, or employee thereof, or of any corporation organized under sections 1131–1134m of Title 12, or in which a Production Credit

Corporation holds stock, or of any regional agricultural credit corporation established pursuant to law, or of the National Agricultural Credit Corporation, a Federal Home Loan Bank, the Federal Home Loan Bank Board, the Home Owners' Loan Corporation, a Federal Savings and Loan Association, a Federal land bank, a joint-stock land bank, a National farm loan association, or of a Federal Researve Bank, upon any application, advance, discount, purchase, purchase agreement, repurchase agreement, commitment or loan or any change or extension of any of the same, by renewal, deferment of action or otherwise, or the acceptance, release, or substitution of security therefor, shall be fined not more than $5,000 or imprisoned not more than two years, or both. (18 U.S.C. 1014.)

Whoever, while acting in any official capacity in the administration of any Act of Congress relating to crop insurance or to the Federal Crop Insurance Corporation speculates in any agricultural commodity or product thereof, to which such enactments apply, or in contracts relating thereto, or in the stock or membership interests of any association or corporation engaged in handling, processing, or disposing of any such commodity or product, shall be fined not more than $10,000 or imprisoned not more than two years, or both. (18 U.S.C. 1903.)

SUGAR ACT OF 1948, AS AMENDED

EXPLANATORY NOTE

The first statute authorizing the imposition of sugar quotas on all areas supplying the United States market, including the mainland cane sugar area, the domestic beet sugar areas, and Hawaii, Puerto Rico, and the Virgin Islands, was the Jones-Costigan Sugar Act. approved in May 1934, which was an amendment to the Agricultural Adjustment Act of 1933. This act also authorized the Secretary to impose a processing tax on sugar and to enter into contracts with domestic growers providing for payments on a production limited to area quotas. In 1936 the production control and processing tax provisions of the Agricultural Adjustment Act were invalidated in the case of *United States* v. *Butler* (297 U.S. 1); however, sugar quotas were continued in effect and were subsequently revised and reenacted in the Sugar Act of 1937. The act of 1937 also provided for payments to producers of sugarcane and sugar beets who complied with specified conditions relating to child labor, farm wages, acreage allotments, soil conservation, and for payments to producers, who were also processors and who have paid to other producers fair prices for sugar beets or sugarcane.

The Sugar Act of 1948, enacted in August 1947, reenacted the Sugar Act of 1937 with certain changes, the most important of which related to the determination of the annual estimate of sugar consumption and the establishment of annual area sugar quotas. The constitutional validity of the quota provisions of the Sugar Act of 1948 has been upheld in the case of *Secretary of Agriculture* v. *Central Roig Refining Company et al.*, 338 U.S. 604. The act was amended in 1951, 65 Stat, 318, in 1956, 70 Stat. 217, in 1958, 72 Stat. 950, in 1959, 73 Stat. 141, in 1960, 74 Stat. 330, in 1961, 75 Stat. 40, and in 1962, 76 Stat. 156, 169.

758-820—65——18

PART VI

SUGAR ACT OF 1948, AS AMENDED [1]

AN ACT

To regulate commerce among the several States, with the Territories and possessions of the United States, and with foreign countries; to protect the welfare of consumers of sugars and of those engaged in the domestic sugar-producing industry; to promote the export trade of the United States; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Sugar Act of 1948." (7 U.S.C. 1100.)

TITLE I—DEFINITIONS

SEC. 101. For the purpose of this Act, except title V—

(a) The term "person" means an individual, partnership, corporation, or association. (7 U.S.C. 1101(a).)

(b) The term "sugars" means any grade or type of saccharine product derived from sugarcane or sugar beets, which contains sucrose, dextrose, or levulose. (7 U.S.C. 1101(b).)

(c) The term "sugar" means raw sugar or direct-consumption sugar. (7 U.S.C. 1101(c).)

(d) The term "raw sugar" means any sugars (exclusive of liquid sugar from foreign countries having liquid sugar quotas), whether or not principally of crystalline structure, which are to be further refined or improved in quality to produce any sugars principally of crystalline structure or liquid sugar. (7 U.S.C. 1101(d).)

(e) The term "direct-consumption sugar" means any sugars principally of crystalline structure and any liquid sugar (exclusive of liquid sugar from foreign countries having liquid sugar quotas), which are not to be further refined or improved in quality. (7 U.S.C. 1101(e).)

(f) The term "liquid sugar" means any sugars (exclusive of sirup of cane juice produced from sugarcane grown in continental United States) which are principally not of crystalline structure and which contain, or which are to be used for the production of any sugars principally not of crystalline structure which contain, soluble nonsugar solids (excluding any foreign substances that may have been added or developed in the product) equal to 6 per centum or less of the total soluble solids. (7 U.S.C. 1101(f).)

(g) Sugars in dry amorphous form shall be considered to be principally of crystalline structure. (7 U.S.C. 1101(g).)

(h) The "raw value" of any quantity of sugars means its equivalent in terms of ordinary commercial raw sugar testing ninety-six sugar

[1] Approved August 8, 1947, 61 Stat. 922. The provisions of the Act set forth are those in effect following the amendments made by Pub. L. 85–539, approved July 19, 1962. The amendments made by Pub. L. 85–535, approved July 13, 1962 may be cited as the "Sugar Act Amendments of 1962".

degrees by the polariscope, determined in accordance with regulations to be issued by the Secretary. The principal grades and types of sugar and liquid sugar shall be translated into terms of raw value in the following manner:

(1) For direct-consumption sugar, derived from sugar beets and testing ninety-two or more sugar degrees by the polariscope, by multiplying the number of pounds thereof by 1.07;

(2) For sugar, derived from sugarcane and testing ninety-two sugar degrees by the polariscope, by multiplying the number of pounds thereof by 0.93;

(3) For sugar, derived from sugarcane and testing more than ninety-two sugar degrees by the polariscope, by multiplying the number of pounds thereof by the figure obtained by adding to 0.93 the result of multiplying 0.0175 by the number of degrees and fractions of a degree of polarization above ninety-two degrees;

(4) For sugar and liquid sugar, testing less than ninety-two sugar degrees by the polariscope, by dividing the number of pounds of the "total sugar content" thereof by 0.972.

(5) The Secretary may establish rates for translating sugar and liquid sugar into terms of raw value for (a) any grade or type of sugar or liquid sugar not provided for in the foregoing and (b) any special grade or type of sugar or liquid sugar for which he determines that the raw value cannot be measured adequately under the provisions of paragraphs (1) to (4), inclusive, of this subsection (h). (7 U.S.C. 1101(h).)

(i) The term "total sugar content" means the sum of the sucrose and reducing or invert sugars contained in any grade or type of sugar or liquid sugar. (7 U.S.C. 1101(i).)

(j) The term "quota," depending upon the context, means (1) that quantity of sugar or liquid sugar which may be brought or imported into the continental United States, for consumption therein, during any calendar year, from Hawaii, Puerto Rico, the Virgin Islands, or a foreign country or group of foreign countries; (2) that quantity of sugar or liquid sugar produced from sugar beets or sugarcane grown in the continental United States which, during any calendar year, may be shipped, transported, or marketed in interstate commerce, or in competition with sugar or liquid sugar shipped, transported, or marketed in interstate or foreign commerce; or (3) that quantity of sugar or liquid sugar which may be marketed in Hawaii or in Puerto Rico, for consumption therein, during any calendar year.[2] (7 U.S.C. 1101(j).)

(k) The term "producer" means a person who is the legal owner, at the time of harvest or abandonment, of a portion or all of a crop of sugar beets or sugarcane grown on a farm for the extraction of sugar or liquid sugar. (7 U.S.C. 1101(k).)

(l) The terms "including" and "include" shall not be deemed to exclude anything not mentioned but otherwise within the meaning of the term defined. (7 U.S.C. 1101(l).)

(m) The term "Secretary" means the Secretary of Agriculture. (7 U.S.C. 1101(m).)

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[2] Amended by Pub. L. 86–592, 74 Stat. 331, approved July 6, 1960.

(n) The term "to be further refined or improved in quality" means to be subjected substantially to the processes of (1) affination or defecation, (2) clarification, and (3) further purification by adsorption or crystallization. The Secretary is authorized, after such hearing and upon such notice as he may by regulations prescribe, to determine whether specific processes to which sugars are subjected are sufficient to meet the requirements of this paragraph (n) and whether sugars of specific qualities are raw sugar within the meaning of paragraph (d) of this section, or direct-consumption sugar within the meaning of paragraph (e) of this section. (7 U.S.C. 1101 (n).)

(o) The term "continental United States" means the 49 States and the District of Columbia.[3] (7 U.S.C. 1101(o).)

TITLE II—QUOTA PROVISIONS

ANNUAL ESTIMATE OF CONSUMPTION IN CONTINENTAL UNITED STATES

SEC. 201. The Secretary shall determine for each calendar year, beginning with the calendar year 1948, the amount of sugar needed to meet the requirements of consumers in the continental United States; such determinations shall be made during the month of December in each year for the succeeding calendar year (in the case of the calendar year 1948, during the first ten days thereof) and at such other times during such calendar years as the Secretary may deem necessary to meet such requirements. In making such determinations the Secretary shall use as a basis the quantity of direct-consumption sugar distributed for consumption, as indicated by official statistics of the Department of Agriculture, during the twelve-month period ending October 31 next preceding the calendar year for which the determination is being made, and shall make allowances for a deficiency or surplus in inventories of sugar, and for changes in consumption because of changes in population and demand conditions, as computed from statistics published by agencies of the Federal Government; and, in order that such determinations shall be made so as to protect the welfare of consumers and of those engaged in the domestic sugar industry by providing such supply of sugar as will be consumed at prices which will not be excessive to consumers and which will fairly and equitably maintain and protect the welfare of the domestic sugar industry, the Secretary, in making any such determination, in addition to the consumption, inventory, population, and demand factors above specified and the level and trend of consumer purchasing power shall take into consideration the relationship between the price for raw sugar that he estimates would result from such determination and the parity index, as compared with the relationship between the average price of raw sugar during the three-year period 1957, 1958, and 1959, and the average of the parity indexes during such three years, with the view to attaining generally stable domestic sugar prices that will carry out over the long term the price objective previously set forth in this section; and in order that the regulation of commerce provided by this Act shall not result in exces-

[3] Added by Pub. L. 86–70, 73 Stat. 141, approved June 25, 1959.

sive prices to consumers, the Secretary shall make such additional allowances as he deems necessary in the amount of sugar determined to be needed to meet requirements of consumers. The term "parity index" as used herein shall mean such index as determined under section 301 of the Agricultural Adjustment Act of 1938, as amended, and as published monthly by the United States Department of Agriculture.[4] (7 U.S.C. 1111.)

PRORATION OF QUOTAS

SEC. 202.[5] Whenever a determination is made, pursuant to section 201, of the amount of sugar needed to meet the requirements of consumers, the Secretary shall establish quotas, or revise existing quotas—

(a)(1) For domestic sugar-producing areas, by appropriating among such areas five million eight hundred and ten thousand short tons, raw value, as follows:

Area	*Short tons, raw value*
Domestic beet sugar	2,650,000
Mainland cane sugar	895,000
Hawaii	1,110,000
Puerto Rico	1,140,000
Virgin Islands	15,000
Total	5,810,000

(2)(A) To the above total of five million eight hundred and ten thousand short tons, raw value, there shall be added an amount equal to 65 per centum of the amount by which the Secretary's determination of requirements of consumers in the continental United States for the calendar year exceeds nine million seven hundred thousand short tons, raw value. Such additional amount shall be apportioned between the domestic beet sugar area and the mainland cane sugar area on the basis of the quotas for such areas established under paragraph (1) of this subsection and the amounts so apportioned shall be added to the quotas for such areas.

(B) Whenever the production of sugar in Hawaii, Puerto Rico, or in the Virgin Islands in any year subsequent to 1961 results in there being available for marketing in the continental United States in any year sugar in excess of the quota for such area for such year established under paragraph (1) of this subsection, the quota for the immediately following year established for such area under paragraph (1) of this subsection shall be increased to the extent of such excess production: *Provided*, That in no event shall the quota for Hawaii, Puerto Rico, or the Virgin Islands, as so increased, exceed the quota which would have been established for such area at the same level of consumption requirements under the provisions of section 202(a) of the Sugar Act of 1948, as amended, in effect immediately prior to the date of enactment of the Sugar Act Amendments of 1962. (7 U.S.C. 1112(a).)

(b) For the Republic of the Philippines, in the amount of one million and fifty thousand short tons, raw value, of sugar. (7 U.S.C. 1112(b).)

[4] Section 201 amended by Pub. L. 87–535, 76 Stat. 156, approved July 13, 1962, which added the language which begins at "shall take into consideration" and ends at "as published monthly by the United States Department of Agriculture".

[5] Section 202 amended by Pub. L. 87–535, 76 Stat. 156, approved July 13, 1962.

(c) (1) For the six-month period ending December 31, 1962, for foreign countries other than the Republic of the Philippines an amount of sugar, raw value, equal to the amount determined pursuant to section 201 less the sum of (i) the quotas established pursuant to subsections (a) and (b) of this section, (ii) the amount of nonquota purchase sugar authorized for importation between January 1 and June 30, 1962, inclusive, pursuant to Sugar Regulation 820, and (iii) the quotas for foreign countries other than the Republic of the Philippines established by Sugar Regulation 811 for the six-month period ending June 30, 1962.

(2) For the calendar years 1963 and 1964, for foreign countries other than the Republic of the Philippines, an amount of sugar, raw value, equal to the amount determined pursuant to section 201 less the sum of the quotas established pursuant to subsections (a) and (b) of this section.

(3) (A) The quotas for foreign countries other than the Republic of the Philippines determined under paragraphs (1) and (2) of this subsection, less five thousand six hundred and sixty-seven short tons, raw value, for 1962 and less eleven thousand three hundred and thirty-two short tons, raw value, for 1963 and 1964, shall be prorated among such countries on the following basis:

Country	*Per centum*
Cuba	57.77
Peru	6.71
Dominican Republic	6.71
Mexico	6.71
Brazil	6.37
British West Indies	3.19
Australia	1.41
Republic of China	1.24
French West Indies	1.06
Colombia	1.06
Nicaragua	.88
Costa Rica	.88
Ecuador	.88
India	.71
Haiti	.71
Guatemala	.71
South Africa	.71
Panama	.53
El Salvador	.36
Paraguay	.35
British Honduras	.35
Fiji Islands	.35
Netherlands	.35

(B) For the six-month period ending December 31, 1962, Canada, United Kingdom, Belgium, and Hong Kong shall be permitted to import into the continental United States the amount of sugar allocated to each in Sugar Regulation 811, issued December 11, 1961 (26 F.R. 11963). For the calendar years 1963 and 1964, Canada, United Kingdom, Belgium, and Hong Kong shall be permitted to import into the continental United States a total of thirteen hundred and thirty-two short tons of sugar, raw value, which amount shall be allocated to such countries in amounts as specified in Sugar

Regulation 811, as amended, issued March 31, 1961 (26 F.R. 2774);

(C) For the six-month period ending December 1962, the Secretary is authorized to allocate to foreign countries not enumerated in subparagraph (A) or (B) an amount of sugar, raw value, not exceeding in the aggregate five thousand short tons. For the calendar years 1963 and 1964, the Secretary is authorized to allocate to foreign countries not enumerated in subparagraph (A) or (B) an amount of sugar, raw value, not exceeding in the aggregate ten thousand short tons. Each foreign country to which an allocation is made under the provisions of this subparagraph for any period or year shall be permitted to import into the continental United States the amount of sugar allocated to it by the Secretary.

(4) (A) Nowithstanding the provisions of paragraph (3) of this subsection, whenever the United States is not in diplomatic relations with any country named in paragraph (3) of this subsection and during such period after resumption of diplomatic relations with such country as the Secretary determines is required to permit an orderly adjustment in the channels of commerce for sugar, the proration or allocation provided for in paragraph (3) of this subsection shall not be made to such country, and a quantity of sugar not to exceed an amount equal to the proration or allocation which would have been made but for the provisions of this paragraph, may be authorized for purchase and importation from foreign countries, except that all or any part of such quantity need not be purchased from any country with which the United States is not in diplomatic relations, or from any country designated by the President whenever he finds and proclaims that such action is required in the national interest. In authorizing the purchase and importation of sugar from foreign countries under this paragraph, special consideration shall be given to countries of the Western Hemisphere and to those countries purchasing United States agricultural commodities.

(B) Of the quantity authorized for purchase and importation under subparagraph (A), the President is authorized to allocate to countries within the Western Hemisphere, for the six-month period ending December 31, 1962, an amount of sugar, raw value, not exceeding in the aggregate seventy-five thousand short tons, and for the calendar years 1963 and 1964, an amount of sugar, raw value, not exceeding in the aggregate one hundred and fifty thousand short tons.[6]

(5) Sugar authorized for purchase pursuant to paragraph (4) of this subsection shall be raw sugar, except that if the Secretary determines that the total quantity is not reasonably available as raw sugar from the countries either named or determined by the Secretary under paragraph (4) of this subsection, he may authorize for purchase for direct consumption from such countries such

[6] Paragraph 4(B) added by Pub. L. 87–539, 76 Stat. 169, approved July 19, 1962.

part of such quantity of sugar as he determines may be required to meet the requirements of consumers in the United States.

(6) Sugar shall not be authorized for purchase pursuant to paragraph (4) of this subsection from any foreign country which imports sugar unless, in the preceding and current calendar year, its aggregate exports of sugar to countries other than the United States equal or exceed its aggregate imports of sugar. (7 U.S.C. 1112(c).)

(d) Whenever in any year any foreign country with a quota or proration thereof of more than ten thousand short tons, raw value, fails to fill such quota or proration by more than ten per centum and at any time during such year the world price of sugar exceeds the domestic price, the quota or proration thereof for such country for subsequent years shall be reduced by an amount equal to the amount by which such country failed to fill its quota or proration thereof, unless the Secretary finds that such failure was due to crop disaster or force majeure or finds that such reduction would be contrary to the objectives of this Act. Any reduction hereunder shall be prorated in the same manner as deficits are prorated under section 204. (7 U.S.C. 1112(d).)

(e) If a foreign country imports sugar, it may not export sugar to the United States to fill its quota or proration thereof for any year unless, in both the preceding and current calendar years, its aggregate exports of sugar to countries other than the United States equal or exceed its aggregate imports of sugar. If sugar is exported to the United States from any foreign country in any year in violation of this subsection (e), the quota or proration thereof for such foreign country for subsequent years shall be reduced by an amount equal to three times the lesser of (i) the amount of such country's excess of imports of sugar over its exports of sugar to countries other than the United States during the preceding or current calendar year, in whichever year an excess or the larger excess occurs, or (ii) the amount of sugar exported to the United States by such country to fill its quota or proration thereof during the calendar year in which the violation of this subsection (e) occurred. The provisions of this subsection shall not apply to sugar exported by any foreign country to the United States to fill any allocation made to it under subsection (c)(3)(C).[7] (7 U.S.C. 1112(e).)

(f) The quota or proration thereof or purchase authorization established for any foreign country may be filled only with sugar produced from sugarbeets or sugarcane grown in such country. (7 U.S.C. 1112(f).)

CONSUMPTION ESTIMATES AND QUOTAS FOR HAWAII AND PUERTO RICO

SEC. 203. In accordance with such provisions of section 201 as he deems applicable, the Secretary shall also determine the amount of sugar needed to meet the requirements of consumers in Hawaii, and in Puerto Rico, and shall establish quotas for the amounts of sugar which may be marketed for local consumption in such areas equal to the amounts determined to be needed to meet the requirements of consumers therein.[8] (7 U.S.C. 1113.)

[7] Last sentence in subsection (e) added by Pub. L. 87–539, 76 Stat. 169, approved July 19, 1962.

[8] Amended by Pub. L. 86–592, 74 Stat. 331, approved July 6, 1960.

PRORATION OF QUOTAS DEFICITS

SEC. 204. (a) The Secretary shall from time to time determine whether, in view of the current inventory of sugar, the estimated production from the acreage of sugarcane or sugarbeets planted, the normal marketings within a calendar year of new-crop sugar and other pertinent factors, any area or country will be unable to market the quota or proration for such area or country. If the Secretary determines that any domestic area or foreign country will be unable to market the quota or proration for such area or country, he shall revise the quota for the Republic of the Philippines by prorating to it an amount of sugar which bears the same ratio to the deficit as the quota for the Republic of the Philippines determined under section 202(b) then in effect bears to the sum of such quota for the Republic of the Philippines and of the prorations to foreign countries named in section 202(c)(3)(A) then in effect; and shall allocate an amount of sugar equal to the remainder of the deficit to foreign countries within the Western Hemisphere named in section 202(c)(3)(A): *Provided*, That no part of any such deficit shall be prorated or allocated to any country not in diplomatic relations with the United States. If the Secretary determines that the Republic of the Philippines will be unable to fill its share of any deficit determined under this subsection, he shall allocate such unfilled amount to foreign countries within the Western Hemisphere named in section 202(c)(3)(A): *Provided*, That no such allocation shall be made to any foreign country not in diplomatic relations with the United States. In making allocations for foreign countries within the Western Hemisphere under this subsection, special consideration shall be given to those countries purchasing United States agricultural commodities. If the Secretary determines that neither the Republic of the Philippines nor the countries within the Western Hemisphere named in section 202(c)(3)(A) can fill all of any such deficit whenever provisions of section 202(c)(4) apply, he shall add such unfilled amount to the quantity of sugar which may be purchased pursuant to section 202(c)(4), and whenever section 202(c)(4) does not apply he shall apportion such unfilled amount on such basis and to such foreign countries in diplomatic relations with the United States as he determines is required to fill such deficit. (7 U.S.C. 1114(a).)

(b) The quota established for any domestic area or the Republic of the Philippines under section 202 shall not be reduced by reason of any determination of a deficit existing in any calendar year under subsection (a) of this section.[9] (7 U.S.C. 1114(b).)

ALLOTMENTS OF QUOTAS OR PRORATIONS

SEC. 205. (a) Whenever the Secretary finds that the allotment of any quota, or proration thereof, established for any area pursuant to the provisions of this Act, is necessary to assure an orderly and adequate flow of sugar or liquid sugar in the channels of interstate or foreign commerce, or to prevent disorderly marketing or importation of sugar or liquid sugar, or to maintain a continuous and stable sup-

[9] Section 204 was amended by Pub. L. 87-535, 76 Stat. 160, approved July 13, 1962, and amended again by Pub. L. 87-539; 76 Stat. 169, approved July 19, 1962.

ply of sugar or liquid sugar, or to afford all interested persons an equitable opportunity to market sugar or liquid sugar within any area's quota, after such hearing and upon such notice as he may by regulations prescribe, he shall make allotments of such quota or proration thereof by allotting to persons who market or import sugar or liquid sugar, for such periods as he may designate, the quantities of sugar or liquid sugar which each such person may market in continental United States, Hawaii, or Puerto Rico, or may import or bring into continental United States, for consumption therein. Allotments shall be made in such manner and in such amounts as to provide a fair, efficient, and equitable distribution of such quota or proration thereof, by taking into consideration the processings of sugar or liquid sugar from sugar beets or sugarcane, limited in any year when proportionate shares were in effect to processings to which proportionate shares, determined pursuant to the provisions of subsection (b) of section 302, pertained; the past marketings or importations of each such person; and the ability of such person to market or import that portion of such quota or proration thereof allotted to him. The Secretary is also authorized in making such allotments, whenever there is involved any allotment that pertains to a new sugarbeet processing plant or factory serving a locality having a substantial sugarbeet acreage for the first time or that pertains to an existing sugarbeet processing plant or factory with substantially expanded facilities added to serve farms having a substantial sugarbeet acreage for the first time, to take into consideration in lieu of or in addition to the foregoing factors of processing, past marketings, and ability to market, the need of establishing an allotment which will permit such marketing of sugar as is necessary for reasonably efficient operation of any such new processing plant or factory or expanded facilities during each of the first two years of its operation. In making such allotments, the Secretary may also take into consideration and make due allowance for the adverse effect of drought, storm, flood, freeze, disease, insects, or other similar abnormal and uncontrollable conditions seriously and broadly affecting any general area served by the factory or factories of such person. The Secretary may also, upon such hearing and notice as he may by regulations prescribe, revise or amend any such allotment upon the same basis as the initial allotment was made.[10] (7 U.S.C. 1115(a).)

(b) An appeal may be taken, in the manner hereinafter provided from any decision making such allotments, or revisions thereof, to the United States Court of Appeals for the District of Columbia in any of the following cases:

(1) By any applicant for an allotment whose application shall have been denied.

(2) By any person aggrieved by reason of any decision of the Secretary granting or revising any allotment made to him. (7 U.S.C. 1115(b).)

(c) Such appeal shall be taken by filing with said court, within twenty days after the decision complained of is effective, notice in writing of said appeal and a statement of the reasons therefor, to-

[10] Amended by Pub. L. 87–535, 76 Stat. 160, approved July 13, 1962.

gether with proof of service of a true copy of said notice and statement upon the Secretary. Unless a later date is specified by the Secretary as part of his decision, the decision complained of shall be considered to be effective as of the date on which public announcement of the decision is made at the office of the Secretary in the city of Washington. The Secretary shall thereupon, and in any event not later than ten days from the date of such service upon him, mail or otherwise deliver a copy of said notice of appeal to each person shown by the records of the Secretary to be interested in such appeal and to have a right to intervene therein under the provisions of this section, and shall at all times thereafter permit any such person to inspect and make copies of appellants' reasons for said appeal at the office of the Secretary in the city of Washington. Within thirty days after the filing of said appeal the Secretary shall file with the court the record upon which the decision complained of was entered, as provided in section 2112 of title 28, United States Code, and a list of all interested persons to whom he has mailed or otherwise delivered a copy of said notice of appeal. (7 U.S.C. 1115(c).)

(d) Within thirty days after the filing of said appeal any interested person may intevene and participate in the proceedings had upon said appeal by filing with the court a notice of intention to intervene and a verified statement showing the nature of the interest of such party together with proof of service of true copies of said notice and statement, both upon the appellant and upon the Secretary. Any person who would be aggrieved or whose interests would be adversely affected by reversal or modification of the decision of the Secretary complained of shall be considered an interested party. (7 U.S.C. 1115(d).)

(e) At the earliest convenient time the court shall hear and determine the appeal upon the record before it, and shall have power, upon such record, to enter a judgment affirming or reversing the decision, and if it enters an order reversing the decision of the Secretary it shall remand the case to the Secretary to carry out the judgment of the court: *Provided, however*, That the review by the court shall be limited to questions of law and that findings of fact by the Secretary, if supported by substantial evidence, shall be conclusive unless it shall clearly appear that the findings of the Secretary are arbitrary or capricious. The court's judgment shall be final, subject, however, to review by the Supreme Court of the United States, upon writ of certiorari on petition therefor, under section 240 of the Judicial Code, as amended (U.S.C., title 28, sec. 1254), by appellant, by the Secretary, or by any interested party intervening in the appeal. (7 U.S.C. 1115(e).)

(f) The court may, in its discretion, enter judgment for costs in favor of or against appellant, and other interested parties intervening in said appeal, but not against the Secretary, depending upon the nature of the issues involved in such appeal and the outcome thereof. (7 U.S.C. 1115(f).)

SUGAR-CONTAINING PRODUCTS

SEC. 206.[11] The sugar or liquid sugar in any product or mixture, which the Secretary determines is the same or essentially the same in composition and use as a sugar-containing product or mixture which was imported into the United States during any three or more of the five years prior to 1960 without being subject to a quota under this Act, shall not be subject to the quota and other provisions of this Act, unless the Secretary determines that the actual or prospective importation or bringing into the United States or Puerto Rico of such sugar-containing product or mixture will substantially interfere with the attainment of the objectives of this Act: *Provided*, That the sugar and liquid sugar in any other product or mixture imported or brought into the United States or Puerto Rico shall be subject to the quota and other provisions of this Act unless the Secretary determines that the actual or prospective importation or bringing in of the sugar-containing product or mixture will not substantially interfere with the attainment of the objectives of this Act. In determining whether the actual or prospective importation or bringing into the United States or Puero Rico of any sugar-containing product or mixture will or will not substantially interfere with the attainment of the objectives of this Act, the Secretary shall take into consideration the total sugar content of the product or mixture in relation to other ingredients or to the sugar content of other products or mixtures for similar use, the costs of the mixture in relation to the costs of its ingredients for use in the United States or Puerto Rico, the present or prospective volume of importations relative to past importations, and other pertinent information which will assist him in making such determination. Determinations by the Secretary that do not subject sugar or liquid sugar in a product or mixture to a quota, may be made pursuant to this section without regard to the rulemaking requirements of section 4 of the Administrative Procedure Act, and by addressing such determinations in writing to named persons and serving the same upon them by mail. If the Secretary has reason to believe it likely that the sugar or liquid sugar in any product or mixture will be subject to a quota under the provisions of this section, he shall make any determination provided for in this section with respect to such product or mixture in conformity with the rulemaking requirements of section 4 of the Administrative Procedure Act. (7 U.S.C. 1116.)

DIRECT CONSUMPTION SUGAR QUOTAS

Sec. 207.[11] (a) The quota for Hawaii established under section 202 for any calendar year may be filled by direct-consumption sugar not to exceed an amount equal to 0.342 per centum of the Secretary's determination for such year issued pursuant to section 201. (7 U.S.C. 1117(a).)

(b) The quota for Puerto Rico established under section 202 for any calendar year may be filled by direct-consumption sugar not to

[11] Sections 206 and 207 amended by Pub. L. 87–535, 76 Stat. 160–161, approved July 13, 1962. The amendment to Sec. 206 shall become effective on the earlier of the date specified in the regulations which implement the Act and published in the Federal Register or sixty days after the date of the enactment of Pub. L., 87–535.

exceed an amount equal to 1.5 per centum of the Secretary's determination for such year issued pursuant to section 201: *Provided*, That one hundred and twenty-six thousand and thirty-three short tons, raw value, of such direct-consumption sugar shall be principally of crystalline structure. (7 U.S.C. 1117(b).)

(c) None of the quota for the Virgin Islands for any calendar year may be filled by direct-consumption sugar. (7 U.S.C. 1117(c).)

(d) Not more than fifty-six thousand short tons of sugar of the quota for the Republic of the Philippines for any calendar year may be filled by direct-consumption sugar as provided under section 201 of the Philippine Trade Agreement Revision Act of 1955. (7 U.S.C. 1117(d).)

(e)(1) None of the proration established for Cuba under section 202(c)(3) for any calendar year and none of the deficit prorations and apportionments for Cuba established under section 204(a) may be filled by direct-consumption sugar.

(2) The proration or allocation established for each foreign country which receives a proration or allocation of twenty thousand short tons, raw value, or less under section 202(c)(3), may be filled by direct-consumption sugar to the extent of the average amount of direct-consumption sugar entered by such country during the years 1957, 1958, and 1959. None of the proration or allocation established for each foreign country which receives a proration or allocation of more than twenty thousand short tons, raw value, under section 202(c)(3), may be filled by direct-consumption sugar. None of the deficit prorations and apportionments for foreign countries established under section 204(a) may be filled by direct-consumption sugar. The provisions of this paragraph shall not apply to any allocation made to a foreign country under section 202(c)(3)(C).[12] (7 U.S.C. 1117(e).)

(f) This section shall not apply with respect to the quotas established under section 203 for marketing for local consumption in Hawaii and Puerto Rico. (7 U.S.C. 1117(f).)

(g) The direct-consumption portions of the quotas established pursuant to this section, and the enforcement provisions of title II applicable thereto, shall continue in effect and shall not be subject to suspension pursuant to the provisions of section 408 of this Act unless the President acting thereunder specifically finds and proclaims that a national economic or other emergency exists with respect to sugar or liquid sugar which requires the suspension of direct-consumption portions of the quotas. (7 U.S.C. 1117(g).)

LIQUID SUGAR FOREIGN QUOTAS

Sec. 208. A quota for liquid sugar for foreign countries for each calendar year is hereby established as follows: two million gallons of sirup of cane juice of the type of Barbados molasses, limited to liquid sugar containing soluble nonsugar solids (excluding any foreign substances that may have been added or developed in the product) of more than 5 per centum of the total soluble solids, which is not to be used

[12] The sentence beginning with the words "The provisions" and ending with "under section 202(c)(3)(C)" was added by Pub. L. 87–539, 76 Stat. 169, approved July 19, 1962.

as a component of any direct-consumption sugar but is to be used as molasses without substantial modification of its characteristics after importation, except that the President is authorized to prohibit the importation of liquid sugar from any foreign country which he shall designate whenever he finds and proclaims that such action is required by the national interest.[13] (7 U.S.C. 1118.)

PROHIBITED ACTS

SEC. 209. All persons are hereby prohibited—

(a) From bringing or importing into the continental United States from Hawaii, Puerto Rico, the Virgin Islands, or foreign countries, (1) any sugar or liquid sugar after the applicable quota, or the proration of any such quota, has been filled, or (2) any direct-consumption sugar after the direct-consumption portion of any such quota or proration has been filled; (7 U.S.C. 1119(a).)

(b) From shipping, transporting, or marketing in interstate commerce, or in competition with sugar or liquid sugar shipped, transported, or marketed in interstate or foreign commerce, any sugar or liquid sugar produced from sugar beets or sugarcane grown in either the domestic-beet-sugar area or the mainland cane-sugar area after the quota for such area has been filled; (7 U.S.C. 1119(b).)

(c) From marketing in either Hawaii or Puerto Rico, for consumption therein, any sugar or liquid sugar after the quota therefor has been filled; (7 U.S.C. 1119(c).)

(d) From exceeding allotment of any quota, direct-consumption portion of any quota, or proration or allocation of any quota, made to them pursuant to the provisions of this Act; (7 U.S.C. 119(d).)

(e) From bringing or importing into the Virgin Islands for consumption therein, any sugar or liquid sugar produced from sugarcane or sugarbeets grown in any area other than Puerto Rico, Hawaii, or the continental United States.[14] (7 U.S.C. 1119(e).)

DETERMINATIONS IN TERMS OF RAW VALUE

SEC. 210. (a) The determinations provided for in sections 201 and 203, and all quotas, prorations, and allotments, except quotas established pursuant to the provisions of section 208, shall be made or established in terms of raw value. (7 U.S.C. 1120(a).)

(b) For the purposes of this title, liquid sugar, except that imported from foreign countries, shall be included with sugar in making the determinations provided for in sections 201 and 203 and in the establishment or revision of quotas, prorations, and allotments. (7 U.S.C. 1120(b).)

EXPORTATION OF SUGAR

SEC. 211. (a) Sugar or liquid sugar entered into the continental United States under an applicable bond established pursuant to orders or regulations issued by the Secretary, for the express purpose of subsequently exporting the equivalent quantity of sugar or liquid sugar as such, or in manufactured articles, shall not be charged against the applicable quota or proration for the country of origin. (7 U.S.C. 1121(a).)

[13] Section 208 amended by Pub. L. 87–535, 76 Stat. 162, approved July 13, 1962.
[14] Sec. 209 amended by Pub. L. 87–535, 76 Stat. 162, approved July 13, 1962.

(b) Exportation within the meaning of sections 309 and 313 of the Tariff Act of 1930 shall be considered to be exportation within the meaning of this section. (7 U.S.C. 1121(b).)

(c)[15] The quota established for any domestic sugar-producing area may be filled only with sugar or liquid sugar produced from sugarbeets or sugarcane grown in such area. (7 U.S.C. 1121(c).)

INAPPLICABILITY OF QUOTA PROVISIONS

SEC. 212.[16] The provisions of this title shall not apply to (1) the first ten short tons, raw value, of sugar or liquid sugar imported from any foreign country, other than Cuba and the Republic of the Philippines, in any calendar year; (2) the first ten short tons, raw value, of sugar or liquid imported from any foreign country, other than Cuba and the Republic of the Philippines, in any calendar year for religious, sacramental, educational, or experimental purposes; (3) liquid sugar imported from any foreign country, other than Cuba and the Republic of the Philippines, in individual sealed containers of such capacity as the Secretary may determine, not in excess of one and one-tenth gallons each; or (4) any sugar or liquid sugar imported, brought into, or produced or manufactured in the United States for the distillation of alcohol, including all polyhydric alcohols, or for livestock feed, or for the production of livestock feed. (7 U.S.C. 1122.)

IMPORT FEE

SEC. 213.[17] (a) An import fee established as provided in subsection (b) of this section shall be paid to the United States as a condition for importing into the continental United States sugar purchased pursuant to paragraph (4)(A) of section 202(c) of this Act. Such fee shall be paid by the person applying to the Secretary for entry and release of sugar. Such payment shall be made in accordance with regulations promulgated by the Secretary. (7 U.S.C. 1123(a).)

(b) Whenever the Secretary determines that the currently prevailing price for raw sugar for the United States market exceeds the market price which he determines, from available information, prevails for raw sugar of foreign countries which may be imported into the continental United States pursuant to paragraph (4)(A) of section 202(c), he shall establish an import fee in such amount as he determines from time to time will approximate the amount by which a domestic price for raw sugar, at a level that will fulfill the domestic price objectives set forth in section 201, would exceed the market price for raw sugar (adjusted for freight to New York, and most-favored-nation tariff) of foreign countries which may be imported into the continental United States pursuant to paragraph (4)(A) of section 202(c). Such fee shall be imposed on a per pound, raw value, basis, and shall be applied uniformly to sugar purchased pursuant to paragraphs (4)(A) and (5) of section 202(c). (7 U.S.C. 1123(b).)

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[15] Amended by Pub. L. 87–535, 76 Stat. 162, approved July 13, 1962.
[16] Amended by Pub. L. 87–535, 76 Stat. 163, approved July 13, 1962.
[17] New section added by Pub. L. 87–535, 76 Stat. 163, approved July 13, 1962, and amended again by Pub. L. 87–539, 76 Stat. 171, approved July 19, 1962. Section 213 shall become effective on the date specified in the regulations which implement the Act, and published in the Federal Register or sixty days after the date of enactment of Pub. L. 87–535, whichever is earlier.

(c) As a condition for importing sugar into the continental United States pursuant to paragraphs (3) and (4)(B) of section 202(c) and section 204(a) of this Act, an import fee shall be paid to the United States during the years 1962, 1963, and 1964, which fee in each such year shall be respectively 10, 20, and 30 per centum of the amount which the Secretary determines from time to time will approximate the amount by which a domestic price for raw sugar, at a level that will fulfill the domestic price objective set forth in section 201 would exceed either the prevailing market price for raw sugar (adjusted for freight to New York, and most-favored-nation tariff) of foreign countries which may be imported into the continental United States pursuant to paragraph (4)(A) of section 202(c), or whenever paragraph (4)(A) of section 202(c) does not apply, the prevailing world market price for raw sugar (adjusted for freight to New York, and most-favored-nation tariff). The fee provided for in this paragraph shall be imposed on a per pound, raw value, basis, and shall be applied uniformly, except that the import fee imposed on any direct-consumption sugar during the years 1962, 1963, and 1964, shall be respectively 0.1, 0.2, and 0.3 of one cent per pound more than the import fee imposed on raw sugar under this paragraph. (7 U.S.C. 1123(c).)

(d) The funds collected as import fees by the Secretary pursuant to the provisions of this section shall be covered into the Treasury as miscellaneous receipts. (7 U.S.C. 1123(d).)

TITLE III—CONDITIONAL PAYMENT PROVISIONS

CONDITIONS OF PAYMENT

SEC. 301. The Secretary is authorized to make payments on the following conditions with respect to sugar or liquid sugar commercially recoverable from the sugar beets or sugarcane grown on a farm for the extraction of sugar or liquid sugar:

(a) That no child under the age of fourteen years shall have been employed or permitted to work on the farm, whether for gain to such child or any other person, in the production, cultivation, or harvesting of a crop of sugar beets or sugarcane with respect to which application for payment is made, except a member of the immediate family of a person who was the legal owner of not less than 40 per centum of the crop at the time such work was performed; and that no child between the ages of fourteen and sixteen years shall have been employed or permitted to do such work, whether for gain to such child or any other person, for a longer period than eight hours in any one day, except a member of the immediate family of a person who was the legal owner of not less than 40 per centum of the crop at the time such work was performed. The Secretary is authorized to make payments, notwithstanding a failure to comply with the conditions provided in this subsection, but the payments made with respect to any crop shall be subject to a deduction of $10 for each child for each day, or a portion of a day, during which such child was employed or permitted to work contrary to the foregoing provisions of this subsection. (7 U.S.C. 1131(a).)

(b)[18] That there shall not have been marketed (or processed), except for livestock feed, or for the production of livestock feed, as

[18] Amended by Pub. L. 87–535, 76 Stat. 165, approved July 13, 1962.

determined by the Secretary, an amount (in terms of planted acreage, weight, or recoverable sugar content) of sugar beets or sugarcane grown on the farm and used for the production of sugar or liquid sugar to be marketed in, or so as to compete with or otherwise directly affect interstate or foreign commerce, in excess of the proportionate share for the farm, if farm proportionate shares are determined by the Secretary pursuant to the provisions of section 302, of the total quantity of sugar beets or sugarcane required to be processed to enable the area in which such sugar beets or sugarcane are produced to meet the quota (and provide a normal carry-over inventory) as estimated by the Secretary for such area for the calendar year during which the larger part of the sugar or liquid sugar from such crop normally would be marketed. (7 U.S.C. 1131(b).)

(c) (1) That all persons employed on the farm in the production, cultivation, or harvesting of sugar beets or sugarcane with respect to which an application for payment is made shall have been paid in full for all such work, and shall have been paid wages therefor at rates not less than those that may be determined by the Secretary to be fair and reasonable after investigation and due notice and opportunity for public hearing; and in making such determinations the Secretary shall take into consideration the standards therefor formerly established by him under the Agricultural Adjustment Act, as amended, and the differences in conditions among various producing areas: *Provided, however*, That a payment which would be payable except for the foregoing provisions of this subparagraph may be made, as the Secretary may determine, in such manner that the laborer will receive an amount, insofar as such payment will suffice, equal to the amount of the accrued unpaid wages for such work, and that the producer will receive the remainder, if any, of such payment.

(2) That the producer on the farm who is also, directly or indirectly a processor of sugar beets or sugarcane, as may be determined by the Secretary shall have paid, or contracted to pay under either purchase or toll agreements, for any sugar beets or sugarcane grown by other producers and processed by him at rates not less than those that may be determined by the Secretary to be fair and reasonable after investigation and due notice and opportunity for public hearing. (7 U.S.C. 1131(c).)

ESTABLISHMENT OF PROPORTIONATE SHARES FOR FARMS

SEC. 302.[19] (a) The amount of sugar or liquid sugar with respect to which payment may be made shall be the amount of sugar or liquid sugar commercially recoverable, as determined by the Secretary, from the sugar beets or sugarcane grown on the farm and marketed (or processed by the producer) not in excess of the proportionate share for the farm, if farm proportionate shares are determined by the Secretary, of the quantity of sugar beets or sugarcane for the extraction of sugar or liquid sugar required to be processed to enable the producing area in which the crop of sugar beets or sugarcane is grown to meet the quota (and provide a normal carry-over inventory) esti-

[19] Amended by Pub. L. 87–535, 76 Stat. 163, approved July 13, 1962.

mated by the Secretary for such area for the calendar year during which the larger part of the sugar or liquid sugar from such crop normally would be marketed. (7 U.S.C. 1132(a).)

(b)(1) Whenever the Secretary determines that the production of sugar from any crop of sugarbeets or sugarcane will be greater than the quantity needed to enable the area to meet the quota, and provide a normal carryover inventory, as estimated by the Secretary for such area for the calendar year during which the larger part of the sugar from such crop normally would be marketed, he shall establish proportionate shares for farms in such area as provided in this subsection. In determining the proportionate shares with respect to a farm, the Secretary may take into consideration the past production on the farm of sugarbeets and sugarcane marketed (or processed) for the extraction of sugar or liquid sugar (within proportionate shares when in effect) and the ability to produce such sugarbeets or sugarcane.

(2) The Secretary may also, in lieu of or in addition to the foregoing factors, take into consideration with respect to the domestic beet sugar area the sugarbeet production history of the person who was a farm operator in the base period, in establishing farm proportionate shares in any State or substantial portion thereof in which the Secretary determines that sugarbeet production is organized generally around persons rather than units of land, other than a State or substantial portion thereof wherein personal sugarbeet production history of farm operators was not used generally prior to 1962 in establishing farm proportionate shares. In establishing proportionate shares for farms in the domestic beet sugar area, the Secretary may first allocate to States (except acreage reserved) the total acreage required to enable the area to meet its quota and provide a normal carryover inventory (hereinafter referred to as the "national sugarbeet acreage requirement") on the basis of the acreage history of sugarbeet production and the ability to produce sugarbeets for extraction of sugar in each State.

(3) In order to make available acreage for growth and expansion of the beet sugar industry, the Secretary, in addition to protecting the interest of new and small producers by regulations generally similar to those heretofore promulgated by him pursuant to this Act, shall reserve each year from the national sugarbeet acreage requirement established by him the acreage required to yield 65,000 short tons, raw value, of sugar. The acreage so reserved shall be distributed on a fair and reasonable basis, when it can be utilized, to farms without regard to any other acreage allocations to States or areas within States determined by him and shall be withheld from such other allocations until it can be so utilized: *Provided, however*, That beginning with 1966, the total acreage previously reserved and not used, plus that reserved in the current year, shall not exceed the acreage required to produce 100,000 short tons, raw value, of sugar. At the time the Secretary distributes the sugarbeet acreage reserve for any year, which determination of distribution shall be made as far in advance of such year as practicable, such distribution shall thereby

be committed to be in effect for the year in which production of sugarbeets is scheduled to commence in a locality or localities determined by the Secretary to receive such reserves for such year, such determination of distribution by the Secretary shall be final, and such commitment of the sugarbeet acreage reserve shall be irrevocable upon issuance of such determination of the Secretary by publication in the Federal Register; except that if the Secretary finds in any case that construction of sugarbeet processing facilities and the contracting for processing of sugarbeets has not proceeded in substantial accordance with the representations made to him as a basis for his determination of distribution of the sugarbeet acreage reserve, he shall revoke such determination in accordance with and upon publication in the Federal Register of such findings. In determining distribution of the sugarbeet acreage reserve and whenever proposals are made to construct sugarbeet processing facilities in two or more localities where sugarbeet production is scheduled to commence in the same year, the Secretary shall base his determination and selection upon the firmness of capital commitment, suitability for growing sugarbeets, the proximity of other mills, need for a cash crop or a replacement crop, and accessibility to sugar markets, and the relative qualifications of localities under such criteria. Whenever there is no interest in constructing a new facility to commence production in a certain year, the Secretary shall give consideration to proposals, if any, to substantially expand existing factory facilities and in such event he shall base his determination of distribution of the sugarbeet acreage reserved on the aforementioned criteria and the extent of the proposed substantial expansion or expansions. If proportionate shares are in effect in the two years immediately following the year for which the sugarbeet acreage reserve is committed for any locality, the acreage of proportionate shares established for farms in such locality in each of such two years shall not be less than the smaller of the acreage committed to such farms or the acreage required to yield 50,000 short tons, raw value, of sugar based upon the yield expectancy initially considered by the Secretary in distributing the sugarbeet acreage reserve to such locality.

(4) The allocation of the national sugarbeet acreage requirement to States for sugarbeet production, as well as the distribution of the sugarbeet acreage reserve, shall be determined by the Secretary after investigation and notice and opportunity for an informal public hearing.

(5) In determining farm proportionate shares, the Secretary shall, insofar as practicable, protect the interests of new producers and small producers and the interest of producers who are cash tenants, share tenants, adherent planters, or sharecroppers and of the producers in any local producing area whose past production has been adversely, seriously, and generally affected by drought, storm, flood, freeze, disease, insects, or other similar abnormal and uncontrollable conditions.

(6) Whenever the Secretary determines it necessary for the effective administration of this subsection in an area where farm

proportionate shares are established in terms of sugarcane acreage, he may consider acreage of sugarcane harvested for seed on the farm in addition to past production of sugarcane for the extraction of sugar in determining proportionate shares as heretofore provided in this subsection; and whenever acreage of sugarcane harvested for seed is considered in determining farm proportionate shares, acreage of sugarcane harvested for seed shall be included in determining compliance with the provisions of section 301(b) of this Act, notwithstanding any other provisions of section 301(b).

(7)[20] For the purposes of establishing proportionate shares hereunder and in order to encourage wise use of land resources, foster greater diversification of agricultural production, and promote the conservation of soil and water resources in Puerto Rico, the Secretary, on application of any owner of a farm in Puerto Rico, is hereby authorized, whenever he determines it to be in the public interest and to facilitate the sale or rental of land for other productive purposes, to transfer the sugarcane production record for any parcel or parcels of land in Puerto Rico owned by the applicant to any other parcel or parcels of land owned by such applicant in Puerto Rico. (7 U.S.C. 1132(b).)

(c) Payments shall be effective with respect to sugar or liquid sugar commercially recoverable from sugar beets and sugarcane grown on a farm commencing with the crop year 1948. (7 U.S.C. 1132(c).)

ACREAGE ABANDONMENT AND CROP DEFICIENCY PAYMENTS

SEC. 303. In addition to the amount of sugar or liquid sugar with respect to which payments are authorized under subsection (a) of section 302, the Secretary is also authorized to make payments, on the conditions provided in section 301, with respect to bona fide adandonment of planted acreage and crop deficiencies of harvested acreage, resulting from drought, flood, storm, freeze, disease, or insects, which cause such damage to all or a substantial part of the crop of sugar beets or sugarcane in the same factory district (as established by the Secretary), county, parish, municipality, or local producing area, as determined in accordance with regulations issued by the Secretary, on the following quantities of sugar or liquid sugar: (1) With respect to such bona fide abandonment of each planted acre of sugar beets or sugarcane, one-third of the normal yield of commercially recoverable sugar or liquid sugar per acre for the farm, as determined by the Secretary; and (2) with respect to such crop deficiencies of harvested acreage of sugar beets or sugarcane, the excess of 80 per centum of the normal yield of commercially recoverable sugar or liquid sugar for such acreage for the farm, as determined by the Secretary, over the actual yield. (7 U.S.C. 1133.)

COMPUTATION OF PAYMENTS AND PERSONS ELIGIBLE FOR PAYMENTS

SEC. 304. (a) The amount of the base rate of payment shall be 80 cents per hundred pounds of sugar or liquid sugar, raw value. (7 U.S.C. 1134(a).)

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[20] Section 302(b)(7) amended by Pub. L. 87–535, 76 Stat. 164, approved July 13, 1962.

(b) All payments shall be calculated with respect to a farm which, for the purposes of this Act, shall be a farming unit as determined in accordance with regulations issued by the Secretary, and in making such determinations, the Secretary shall take into consideration the use of common work stock, equipment, labor, management, and other pertinent factors. (7 U.S.C. 1134(b).)

(c) The total payment with respect to a farm shall be the product of the base rate specified in subsection (a) of this section multiplied by the amount of sugar and liquid sugar, raw value, with respect to which payment is to be made, except that reduction shall be made from such total payment in accordance with the following scale of reductions:

That portion of the quantity of sugar and liquid sugar which is included within the following intervals of short tons, raw value:

Reduction in the basic rate of payment per hundredweight of such portion	
350 to 700	$0.05
700 to 1,000	.10
1,000 to 1,500	.20
1,500 to 3,000	.25
3,000 to 6,000	.275
6,000 to 12,000	.30
12,000 to 30,000	.325
More than 30,000	.50

(7 U.S.C. 1134(c).)

(d) Application for payment shall be made by, and payments shall be made to, the producer or, in the event of his death, disappearance, or incompetency, his legal representative, or heirs: *Provided, however*, That all producers on the farm shall signify in the application for payment the percentage of the total payment with respect to the farm to be made to each producer: *And provided further*, That payments may be made, (1) in the event of the death, disappearance, or incompetency of a producer, to such beneficiary as the producer may designate in the application for payment; (2) to one producer of a group of two or more producers, provided all producers on the farm designate such producer in the application for payment as sole recipient for their benefit of the payment with respect to the farm; or (3) to a person who is not a producer, provided such person controls the land included within the farm with respect to which the application for payment is made and is designated by the sole producer (or all producers) on the farm, as sole recipient for his or their benefit, of the payment with respect to the farm. (7 U.S.C. 1134(d).)

USE OF LOCAL COMMITTEES AND OTHER AGENCIES

SEC. 305. In carrying out the provisions of titles II and III of this Act, the Secretary is authorized to utilize local committees of sugar beet or sugarcane producers, State and county agricultural conservation committees, or the Agricultural Extension Service and other agencies, and the Secretary may prescribe that all or a part of the expenses of such committees may be deducted from the payments herein authorized. (7 U.S.C. 1135.)

FINALITY OF DETERMINATIONS

SEC. 306. The facts constituting the basis for any payment, or the amount thereof authorized to be made under this title, officially determined in conformity with rules or regulations prescribed by the Secretary, shall be reviewable only by the Secretary, and his determinations with respect thereto shall be final and conclusive. (7 U.S.C. 1136.)

APPLICABILITY OF TITLE III

SEC. 307.[21] This title shall apply to the continental United States, Hawaii, Puerto Rico, and the Virgin Islands. (7 U.S.C. 1137.)

TITLE IV—GENERAL PROVISIONS

EXPENDITURES BY SECRETARY

SEC. 401. For the purposes of this Act, the Secretary may make such expenditures as he deems necessary to carry out the provisions of this Act, including personal services and rents in the District of Columbia and elsewhere. (7 U.S.C. 1151.)

APPROPRIATIONS AND AVAILABILITY OF FUNDS

SEC. 402. (a) There is hereby authorized to be appropriated for each fiscal year for the purposes and administration of this Act the funds necessary to make the payments provided for in title III of this Act and such other amounts as the Congress determines to be necessary for such fiscal year to carry out the other provisions of the Act. (7 U.S.C. 1152(a).)

(b) All funds available for carrying out this Act shall be available for allotment to the bureaus and offices of the Department of Agriculture and for transfer to such other agencies of the Federal Government as the Secretary may request to cooperate or assist in carrying out the provisions of this Act. (7 U.S.C. 1152(b).)

(c) The funds made available for the purpose of enabling the Secretary to carry into effect the provisions of the Sugar Act of 1937, as amended, during the fiscal year 1948 are also hereby made available to the Secretary for purposes of administration of the provisions of this Act during the fiscal year 1948. (7 U.S.C. 1152(c).)

REGULATIONS AND DETERMINATIONS

SEC. 403. (a) The Secretary is authorized to make such orders or regulations, which shall have the force and effect of law, as may be necessary to carry out the powers vested in him by this Act. Any person knowingly violating any order or regulation of the Secretary issued pursuant to this Act shall, upon conviction, be punished by a fine of not more than $100 for each such violation. (7 U.S.C. 1153(a).)

(b) Each determination issued by the Secretary in connection with quotas and deficits under title II or payments under title III of this Act shall be promptly published in the Federal Register and shall be accompanied by a statement of the bases and considerations upon which such determination was made. (7 U.S.C. 1153(b).)

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[21] Amended by Pub. L. 86-592, 74 Stat. 331, approved July 6, 1960.

JURISDICTION OF COURTS

SEC. 404.[22] The several district courts of the United States are hereby vested with jurisdiction specifically to enforce, and to prevent and restrain any person from violating, the provisions of this Act or of any order or regulation made or issued pursuant to this Act. If and when the Secretary shall so request, it shall be the duty of the several United States attorneys of the United States, in their respective districts, to institute proceedings to enforce the remedies and to collect the penalties, fees and forfeitures provided for in this Act. The remedies provided for in this Act shall be in addition to, and not exclusive of, any of the remedies or penalties existing at law or in equity. (7 U.S.C. 1154.)

CIVIL PENALTIES

SEC. 405. (a) Any person who knowingly violates, or attempts to violate, or who knowingly participates or aids in the violation of any of the provisions of section 209, or any person who brings or imports into the continental United States direct-consumption sugar after the quantities specified in section 207 have been filled, shall forfeit to the United States the sum equal to three times the market value, at the time of the commission of any such act, (1) of that quantity of sugar or liquid sugar by which any quota, proration, or allotment is exceeded, or (2) of that quantity brought or imported into the continental United States after the quantities specified in section 207 have been filled, which forfeiture shall be recoverable in a civil suit brought in the name of the United States. (7 U.S.C. 1155(a).)

(b) Any person whose sugar processing operations otherwise meet the requirements of section 101(n) and who subjects to such processes sugar imported or brought into the continental United States under a declaration that it is raw sugar but which sugar subsequently is determined to be of direct-consumption quality, shall forfeit to the United States a sum equal to 1 cent per pound for each pound, raw value, of such sugar in excess of that part of the direct-consumption portion of the applicable quota or proration or allotment thereof remaining unfilled at the time of such determination, which forfeiture shall be recoverable in a civil suit brought in the name of the United States. (7 U.S.C. 1155(b).)

FURNISHING INFORMATION TO SECRETARY

SEC. 406. All persons engaged in the the manufacturing, marketing, or transportation of industrial use of sugar or liquid sugar, and having information which the Secretary deems necessary to enable him to administer the provisions of this Act, shall, upon the request of the Secretary, furnish him with such information. Any person willfully failing or refusing to furnish such information or furnishing willfully any false information, shall upon conviction be subject to a penalty of not more than $1,000 for each such violation. (7 U.S.C. 1156.)

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[22] Amended by Pub. L. 87–535, 76 Stat. 166, approved July 13, 1962.

SUGAR INVESTMENTS BY OFFICIALS PROHIBITED

SEC. 407. No person shall, while acting in any official capacity in the administration of this Act, invest or speculate in sugar or liquid sugar, contracts relating thereto, or the stock or membership interests of any association or corporation engaged in the production or manufacturing of sugar or liquid sugar. Any person violating this section shall upon conviction thereof be fined not more than $10,000 or imprisoned not more than two years, or both. The provisions of this section shall not apply to persons whose services are obtained pursuant to section 305. (7 U.S.C. 1157.)

SUSPENSION OF QUOTAS

SEC. 408.[23] (a) Whenever pursuant to the provisions of this Act the President finds and proclaims that a national economic or other emergency exists with respect to sugar or liquid sugar, he shall by proclamation suspend the operation, except as provided in section 207 of this Act, of all the provisions of title II above, and, thereafter, the operation of such title shall continue in suspense until the President finds and proclaims that the facts which occasioned such suspension no longer exist. The Secretary shall make such investigations and reports thereon to the President as may be necessary to aid him in carrying out the provisions of this section. (7 U.S.C. 1158(a).)

(b) In the event the President, in his discretion, determines that any foreign country having a quota or receiving any authorization under this Act to import sugar into the United States, has been or is allocating the distribution of such quota or authorization within that country so as to discriminate against citizens of the United States, he shall suspend the quota or other authorization of that country until such time as he has received assurances, satisfactory to him, that the discrimination will not be continued. Any quantity so suspended shall be authorized for purchase in accordance with the provisions of section 202(c)(4), or apportioned in accordance with section 204(a), whichever procedure is applicable. (7 U.S.C. 1158(b).)

(c) In any case in which the President determines that a nation or a political subdivision thereof has hereafter (1) nationalized, expropriated, or otherwise seized the ownership or control of the property of United States citizens or (2) imposed upon or enforced against such property or the owners thereof discriminatory taxes or other exactions, or restrictive maintenance or operational conditions not imposed or enforced with respect to property of a like nature owned or operated by its own nationals or the nationals of any government other than the Government of the United States, and has failed within six months following the taking of action in either of such categories to take steps determined by the President to be appropriate and adequate to remedy such situation and to discharge its obligations under international law toward such citizens, including the prompt payment to the owner or owners of such property so nationalized, expropriated, or otherwise seized, or to arrange, with the agreement of the parties concerned, for submitting the question in dispute to arbitration or con-

[23] Section 408(b) was amended and section 408(c) was added by Pub. L. 87–535, 76 Stat. 166, approved July 13, 1962.

ciliation in accordance with procedures under which a final and binding decision or settlement will be reached and full payment or arrangements with the owners for such payment made within twelve months following such submission, the President shall suspend any quota, proration of quota, or authorization to purchase and import sugar under this Act of such nation until he is satisfied that appropriate steps are being taken. Any quantity so suspended shall be authorized for purchase in accordance with the provisions of section 202(c)(4), or apportioned in accordance with section 204(a) whichever procedure is applicable. (7 U.S.C. 1158(c).)

SURVEYS AND INVESTIGATIONS

SEC. 409. Whenever the Secretary determines that such action is necessary to effectuate the purposes of this Act, he is authorized, if first requested by persons constituting or representing a substantial proportion of the persons affected in any one of the five domestic sugar-producing areas, to make for such area surveys and investigations to the extent he deems necessary, including the holding of public hearings, and to make recommendations with respect to (a) the terms and conditions of contracts between the producers and processors of sugar beets and sugarcane in such areas and (b) the terms and conditions of contracts between laborers and producers of sugar beets and sugarcane in such area. In carrying out the provisions of this section, information shall not be made public with respect to the individual operations of any processor, producer, or laborer. (7 U.S.C. 1159.)

SEC. 410. The Secretary is authorized to conduct surveys, investigations and research relating to the conditions and factors affecting the methods of accomplishing most effectively the purposes of this Act and for the benefit of agriculture generally in any area. Notwithstanding any provision of existing law, the Secretary is authorized to make public such information as he deems necessary to carry out the provisions of this Act. (7 U.S.C. 1160.)

INTERNATIONAL SUGAR AGREEMENT

SEC. 411. The Secretary is authorized to issue such regulations as may be necessary to carry out article 7 of the International Sugar Agreement for the Regulation of the Production and Marketing of Sugar (ratified by and with the advice and consent of the United States Senate on April 29, 1954), restricting importations of sugar into the United States from foreign countries not participating in such agreement, or to carry out the corresponding provisions of any such future agreements ratified by and with the advice and consent of the United States Senate. (7 U.S.C. 1161.)

TERMINATION OF ACT

SEC. 412. The powers vested in the Secretary under this Act shall terminate on December 31, 1966, except that the Secretary shall have power to make payments under title III under programs applicable to the crop year 1966 and previous crop years.[24] (7 U.S.C. 1101, note.)

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[24] Amended by Pub. L. 87–535, 76 Stat. 166, approved July 13, 1962.

EFFECTIVE DATE

SEC. 413.[25] * * *.

EXCISE TAXES WITH RESPECT TO SUGAR[26]

INTERNAL REVENUE CODE OF 1954

CHAPTER 37

Subchapter A—Sugar

SEC. 4501. IMPOSITION OF TAX.

(a)[27] GENERAL.—There is hereby imposed upon manufactured sugar manufactured in the United States, a tax, to be paid by the manufacturer at the rate of 0.53 cent per pound of the total sugars therein. The manufacturer shall pay the tax with respect to manufactured sugar (1) which has been sold, or used in the production of other articles, by the manufacturer during the preceding month (if the tax has not already been paid) and (2) which has not been so sold or used within 12 months ending during the preceding calendar month, after it was manufactured (if the tax has not already been paid). For the purpose of determining whether sugar has been sold or used within 12 months after it was manufactured, sugar shall be considered to have been sold or used in the order in which it was manufactured. (26 U.S.C. 4501(a).)

(b)[28] TERMINATION OF TAX.—No tax shall be imposed under this subchapter on the manufacture or use of sugar or articles composed in chief value of sugar after June 30, 1967. Notwithstanding the provisions of subsection (a), no tax shall be imposed under this subchapter with respect to unsold sugar held by manufacturer on June 30, 1967, or with respect to sugar or articles composed in chief value of sugar held in customs custody or control on such date. (26 U.S.C. 4501(b).)

SEC. 4502. DEFINITIONS.

For the purposes of this subchapter—

(1) MANUFACTURER.—Any person who acquires any sugar which is to be manufactured into manufactured sugar but who, without further refining or otherwise improving it in quality, sells such sugar as manufactured sugar or uses such sugar as manufactured sugar in the production of other articles for sale shall be considered, for the purposes of section 4501(a), the manufacturer of manufactured sugar and, as such, liable for the tax under section 4501(a) with respect thereto.

(2) PERSON.—The term "person" means an individual, partnership, corporation, or association.

(3) MANUFACTURED SUGAR.—The term "manufactured sugar" means any sugar derived from sugar beets or sugarcane, which is not to be, and which shall not be, further refined or otherwise

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[25] Repealed by Pub. L. 87–535, 76 Stat. 166, approved July 13, 1962.

[26] Only those provisions of the Internal Revenue Code of 1954 which became effective January 1, 1955, and subsequent amendments which deal directly with sugar are included. See title 26 of the United States Code for general definitions, time and place for filing returns and paying taxes, interest, abatements, credits, refunds, etc.

[27] Sec. 501(a) of Pub. L. 87–456, 76 Stat. 79, approved May 24, 1962, amended the first sentence. The amendment was to become effective with respect to articles entered, or withdrawn from warehouse, for consumption on or after the 10th day following the date of proclamation of the President provided for in sec. 102 of such Act. Presidential Proclamation No. 3548 was issued on August 21, 1963, 28 F.R. 9279.

[28] Former subsec. (b) was repealed and former subsec. (c) was amended and redesignated subsec. (b) by Pub. L. 87–456, 76 Stat. 77, approved May 24, 1962; for effective date of this amendment see footnote 27.

improved in quality; except sugar in liquid form which contains nonsugar solids (excluding any foreign substance that may have been added or developed in the product) equal to more than 6 per centum of the total soluble solids and except also sirup of cane juice produced from sugarcane grown in continental United States. The grades or types of sugar within the meaning of this definition shall include, but shall not be limited to, granulated sugar, lump sugar, cube sugar, powered sugar, sugar in the form of blocks, cones, or molded shapes, confectioners' sugar, washed sugar, centrifugal sugar, clarified sugar, turbinado sugar, plantation white sugar, muscovado sugar, refiners' soft sugar, invert sugar mush, raw sugar, sirups, molasses, and sugar mixtures.

(4) TOTAL SUGARS.—The term "total sugars" means the total amount of the sucrose and of the reducing or invert sugars.

(5) UNITED STATES.—The term "United States" shall be deemed to include the States, the District of Columbia, and Puerto Rico. (26 U.S.C. 4502.)

SEC. 4503. EXEMPTIONS FOR SUGAR MANUFACTURED FOR HOME CONSUMPTION.

No tax shall be required to be paid under sec. 4501(a) upon the manufacture of manufactured sugar by or for the producer of the sugar beets or sugarcane from which such manufactured sugar was derived, for consumption by the producer's own family, employees, or household. (26 U.S.C. 4503.)

CHAPTER 65—ABATEMENTS, CREDITS, AND REFUNDS

SEC. 6418. SUGAR.

(a) USE AS LIVESTOCK FEED OR FOR DISTILLATION OF ALCOHOL.—Upon the use of any manufactured sugar, or article manufactured therefrom, as livestock feed, or in the production of livestock feed, or for the distillation of alcohol, there shall be paid by the Secretary or his delegate to the person so using such manufactured sugar, or article manufactured therefrom, the amount of any tax paid under section 4501 with respect thereto. (26 U.S.C. 6418(a).)

(b) [29] EXPORTATION.—Upon the exportation from the United States to a foreign country, or the shipment from the United States to any possession of the United States except Puerto Rico, of any manufactured sugar, or any article manufactured wholly or partly from manufactured sugar with respect to which tax under the provisions of section 4501(a) has been paid, the amount of such tax shall be paid by the Secretary or his delegate to the consignor named in the bill of lading under which the article was exported or shipped to a possession, or to the shipper, or to the manufacturer of the manufactured sugar or of the articles exported, if the consignor waives any claim thereto in favor of such shipper or manufacturer. (26 U.S.C. 6418(b).)

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[29] Subsec. (b) was amended by Pub. L. 87–456, 76 Stat. 77, approved May 24, 1962; for effective date of this amendment see footnote 27.

CHAPTER 66—LIMITATIONS

SEC. 6511. LIMITATIONS ON CREDIT OR REFUND.

* * * * * * *

(e) SPECIAL RULES IN CASE OF MANUFACTURED SUGAR.—

(1) USE AS LIVESTOCK FEED OR FOR DISTILLATION OF ALCOHOL.—No payment shall be allowed under section 6418(a) unless within 2 years after the right to such payment has accrued a claim therefor is filed by the person entitled thereto.

(2) EXPORTATION.—No payment shall be allowed under section 6418(b) unless within 2 years after the right to such payment has accrued a claim therefor is filed by the person entitled thereto. (26 U.S.C. 6511(e).)

CHAPTER 75—CRIMES, OTHER OFFENSES, AND FORFEITURES

SEC. 7240. OFFICIALS INVESTING OR SPECULATING IN SUGAR.

Any person, while acting in an official capacity in the administration of subchapter A of chapter 37, relating to manufactured sugar, who invests or speculates in sugar or liquid sugar, contracts relating thereto, or the stock or membership interests of any association or corporation engaged in the production or manufacture of sugar or liquid sugar, shall be dismissed from office or discharged from employment and shall be guilty of a felony and, upon conviction thereof, be fined not more than $10,000, or imprisoned not more than 2 years, or both. (26 U.S.C. 7240.)

PART VII

MISCELLANEOUS LAWS

EXPLANATORY NOTE

Included in this part of the compilation are certain miscellaneous laws which govern or affect certain programs and functions of several agencies of the Department of Agriculture.

Under the heading entitled "Statutes Relating to Imports" are sec. 206 of the Agricultural Act of 1956, sec. 22 of the Agricultural Adjustment Act of 1933 (reenacted by the Agricultural Marketing Act of 1937) and Public Law 88–482.

Secs. 326–328 of the Food and Agriculture Act of 1962 relates to acreage diversion programs.

The Agricultural Marketing Agreement Act of 1937 reenacted and amended certain provisions of the Agricultural Adjustment Act of 1933, as amended, which related to marketing agreements and orders.

The National School Lunch Act provides for distribution of commodities to schools for utilization in the school-lunch program.

The Food Stamp Act of 1964 provides for issuance of food stamp coupons to low income households.

Under the heading entitled "Declarations of Policy" are sec. 2 of the Agricultural Act of 1961, sec. 402 of the Food and Agriculture Act of 1962 and sec. 204 of the Agricultural Act of 1954.

Secs. 102–104 of the Agricultural Act of 1961 provides for the consultation of the Secretary of Agriculture with farmers and farm organizations on farm legislation.

Sec. 601 of the Agricultural Act of 1954 provides that the Secretary of Agriculture acquire information regarding the competition and demand for United States agricultural products for interpretation and dissemination in the United States.

Public Law 88–584 provides for the establishment of federal agricultural services to Guam.

The Act of December 20, 1944, authorizes the Secretary of Agriculture to compromise, adjust, or cancel certain debts of farmers to the United States.

Public Law 664 (the Cargo Preference Act) provides for the transportation of a substantial portion of waterborne cargoes in U.S.-flag vessels.

The Act of August 27, 1958, provides for humane methods of slaughtering livestock.

STATUTES RELATING TO IMPORTS

Agricultural Act of 1956—SEC. 204. The President may, whenever he determines such action appropriate, negotiate with representatives of foreign governments in an effort to obtain agreements limiting the export from such countries and the importation into the United States of any agricultural commodity or product manufactured therefrom or textiles or textile products, and the President is authorized to issue regulations governing the entry or withdrawal from warehouse of any such commodity, product, textiles, or textile products to carry out any such agreement. In addition, if a multilateral agreement has been or shall be concluded under the authority of this section among countries accounting for a significant part of world trade in the articles with respect to which the agreement was concluded, the President may also issue, in order to carry out such an agreement, regulations governing the entry or withdrawal from warehouse of the same articles which are the products of countries not parties to the agreement.[1] Nothing herein shall affect the authority provided under section 22 of the Agricultural Adjustment Act (of 1933) as amended. (7 U.S.C. 1854.)

Agricultural Adjustment Act of 1933—SEC. 22.[2] (a) Whenever the Secretary of Agriculture has reason to believe that any article or articles are being or are practically certain to be imported into the United States under such conditions and in such quantities as to render or tend to render ineffective, or materially interfere with, any program or operation undertaken under this title or the Soil Conservation and Domestic Allotment Act, as amended, or section 32, Public Law numbered 320, Seventy-fourth Congress, approved August 24, 1935, as amended, or any loan, purchase, or other program or operation undertaken by the Department of Agriculture, or any agency operating under its direction, with respect to any agricultural commodity or product thereof, or to reduce substantially the amount of any product processed in the United States from any agricultural commodity or product thereof with respect to which any such program or operation is being undertaken, he shall so advise the President, and, if the President agrees that there is reason for such belief, the President shall cause an immediate investigation to be made by the United States Tariff Commission, which shall give precedence to investigations under this section to determine such facts. Such inves-

[1] This sentence added by the Act of June 19, 1962, 76 Stat. 104.

[2] See also sec. 202(a) of the Agricultural Act of 1956. Sec. 22 was added by the Act of August 24, 1935 (49 Stat. 773). As originally enacted this section authorized the President to restrict the importations of any agricultural commodity or product whenever he found, after investigation by the Tariff Commission and on the basis of its findings and recommendations made pursuant thereto, that such importations were adversely affecting programs or operations under the Agricultural Adjustment Act of 1933. Sec. 22 has been amended several times and was revised in its entirety by sec. 3 of the Agricultural Act of 1948 (62 Stat. 1247) and again by sec. 3 of the Act of June 28, 1950 (64 Stat. 261). The President is now authorized to impose quantitative restrictions (quotas) and fees on any agricultural commodity or product whenever he finds, pursuant to appropriate proceedings by the Tariff Commission, that imports of such commodity or product adversely affect or seriously threaten any program or operation undertaken by the Department of Agriculture. The Secretary of Agriculture has the responsibility of advising the President regarding the need for action under sec. 22. In addition, the Secretary of Agriculture is charged with the responsibility of determining the need for emergency action under sec. 22 with respect to perishable agricultural commodities. Presidential Executive Order No. 7233, dated November 23, 1935 (19 CFR, §§ 201, 204) contains the regulations governing investigations under this section. For statement of the policies and procedures of the Department of Agriculture in discharging its responsibilities under sec. 22, see 17 F.R. 8287, 7 CFR, Part 6 (September 16, 1952).

tigation shall be made after due notice and opportunity for hearing to interested parties, and shall be conducted subject to such regulations as the President shall specify. (7 U.S.C. 624(a).)

(b) If, on the basis of such investigation and report to him of findings and recommendations made in connection therewith, the President finds the existence of such facts, he shall by proclamation impose such fees not in excess of 50 per centum ad valorem or such quantitative limitations on any article or articles which may be entered, or withdrawn from warehouse, for consumption as he finds and declares shown by such investigation to be necessary in order that the entry of such article or articles will not render or tend to render ineffective, or materially interfere with, any program or operation referred to in subsection (a) of this section, or reduce substantially the amount of any product processed in the United States from any such agricultural commodity or product thereof with respect to which any such program or operation is being undertaken: *Provided*, That no proclamation under this section shall impose any limitation on the total quantity of any article or articles which may be entered, or withdrawn from warehouse, for consumption which reduces such permissible total quantity to proportionately less than 50 per centum of the total quantity of such article or articles which was entered, or withdrawn from warehouse, for consumption during a representative period as determined by the President: *And provided further*, That in designating any article or articles, the President may describe them by physical qualities, value, use, or upon such other bases as he shall determine.

In any case where the Secretary of Agriculture determines and reports to the President with regard to any article or articles that a condition exists requiring emergency treatment, the President may take immediate action under this section without awaiting the recommendations of the Tariff Commission, such action to continue in effect pending the report and recommendations of the Tariff Commission and action thereon by the President.[3] (7 U.S.C. 624(b).)

(c) The fees and limitations imposed by the President by proclamation under this section and any revocation, suspension, or modification thereof, shall become effective on such date as shall be therein specified, and such fees shall be treated for administrative purposes and for the purposes of section 32 of Public Law numbered 320, Seventy-fourth Congress, approved August 24, 1935, as amended, as duties imposed by the Tariff Act of 1930, but such fees shall not be considered as duties for the purpose of granting any preferential concession under any international obligation of the United States. (7 U.S.C. 624(c).)

(d) After investigation, report, finding, and declaration in the manner provided in the case of a proclamation issued pursuant to subsection (b) of this section, any proclamation or provision of such proclamation may be suspended or terminated by the President whenever he finds and proclaims that the circumstances requiring the proclamation or provision thereof no longer exist or may be modified by the President whenever he finds and proclaims that changed cir-

[3] Paragraph added by sec. 104 of the Trade Agreements Extension Act of 1953, 67 Stat. 472.

cumstances require such modification to carry out the purposes of this section. (7 U.S.C. 624(d).)

(e) Any decision of the President as to facts under this section shall be final. (7 U.S.C. 624(e).)

(f)[4] No trade agreement or other international agreement heretofore or hereafter entered into by the United States shall be applied in a manner inconsistent with the requirements of this section. (7 U.S.C. 624(f).)

PUBLIC LAW 88-482[5]

AUGUST 22, 1964

AN ACT

To provide for the free importation of certain wild animals, and to provide for the imposition of quotas on certain meat and meat products.

SEC. 1. (Amendments to Title I of the Tariff Act of 1930.)

SEC. 2. (a) It is the policy of the Congress that the aggregate quantity of the articles specified in items 106.10 (relating to fresh, chilled, or frozen cattle meat) and 106.20 (relating to fresh, chilled, or frozen meat of goats and sheep (except lambs)) of the Tariff Schedules of the United States which may be imported into the United States in any calendar year beginning after December 31, 1964, should not exceed 725,400,000 pounds; except that this quantity shall be increased or decreased for any calendar year by the same percentage that estimated average annual domestic commercial production of these articles in that calendar year and the two preceding calendar years increases or decreases in comparison with the average annual domestic commercial production of these articles during the years 1959 through 1963, inclusive.

(b) The Secretary of Agriculture, for each calendar year after 1964, shall estimate and publish—

(1) before the beginning of such calendar year, the aggregate quantity prescribed for such calendar year by subsection (a), and

(2) before the first day of each calendar quarter in such calendar year, the aggregate quantity of the articles described in subsection (a) which (but for this section) would be imported in such calendar year.

In applying paragraph (2) for the second or any succeeding calendar quarter in any calendar year, actual imports for the preceding calendar quarter or quarters in such calendar year shall be taken into account to the extent data is available.

(c)(1) If the aggregate quantity estimated before any calendar quarter by the Secretary of Agriculture pursuant to subsection (b)(2) equals or exceeds 110 percent of the aggregate quantity estimated by him pursuant to subsection (b)(1), and if there is no limitation in effect under this section with respect to such calendar year, the President shall by proclamation limit the total quantity of the articles described in subsection (a) which may be entered, or withdrawn from warehouse, for consumption, during

[4] The provisions of this subsec. (f) were substituted for the original provisions by sec. 8(b) of the Trade Agreements Extension Act of 1951, approved June 16, 1951, 65 Stat. 72, 75.

[5] 78 Stat. 594, 19 U.S.C. 1202 note.

such calendar year, to the aggregate quantity estimated for such calendar year by the Secretary of Agriculture pursuant to subsection (b) (1).

(2) If the aggregate quantity estimated before any calendar quarter by the Secretary of Agriculture pursuant to subsection (b) (2) does not equal or exceed 110 percent of the aggregate quantity estimated by him pursuant to subsection (b) (1), and if a limitation is in effect under this section with respect to such calendar year, such limitation shall cease to apply as of the first day of such calendar quarter; except that any limitation which has been in effect for the third calendar quarter of any calendar year shall continue in effect for the fourth calendar quarter of such year unless the proclamation is suspended or the total quantity is increased pursuant to subsection (d).

(3) The Secretary of Agriculture shall allocate the total quantity proclaimed under paragraph (1), and any increase in such quantity pursuant to subsection (d), among supplying countries on the basis of the shares such countries supplied to the United States market during a representative period of the articles described in subsection (a), except that due account may be given to special factors which have affected or may affect the trade in such articles. The Secretary of Agriculture shall certify such allocations to the Secretary of the Treasury.

(d) The President may suspend any proclamation made under subsection (c), or increase the total quantity proclaimed under such subsection, if he determines and proclaims that—

(1) such action is required by overriding economic or national security interests of the United States, giving special weight to the importance to the Nation of the economic well-being of the domestic livestock industry;

(2) the supply of articles of the kind described in subsection (a) will be inadequate to meet domestic demand at reasonable prices; or

(3) trade agreements entered into after the date of the enactment of this Act ensure that the policy set forth in subsection (a) will be carried out.

Any such suspension shall be for such period, and any such increase shall be in such amount, as the President determines and proclaims to be necessary to carry out the purposes of this subsection.

(e) The Secretary of Agriculture shall issue such regulations as he determines to be necessary to prevent circumvention of the purposes of this section.

(f) All determinations by the President and the Secretary of Agriculture under this section shall be final.

MISCELLANEOUS PROVISIONS RELATING TO ACREAGE DIVERSION PROGRAMS

Food and Agriculture Act of 1962—SEC. 326.[6] Notwithstanding any other provision of law, performance rendered in good faith in reliance upon action or advice of an authorized representative of the Secretary may be accepted as meeting the requirements of subsec-

[6] 76 Stat. 631, amended by Pub. L. 88–26, 77 Stat. 47.

tions (c), (d), (g), and (h), of section 16 of the Soil Conservation and Domestic Allotment Act, as amended, or of section 307 of the Food and Agriculture Act of 1962, section 339 of the Agricultural Act of 1938, as amended, or of section 124 of the Agricultural Act of 1961, and payment may be made therefor in accordance with such action or advice to the extent the Secretary deems it desirable in order to provide fair and equitable treatment. (7 U.S.C. 1339a.)

SEC. 327. In the establishment of State, county, and farm acreage allotments for wheat under the Agricultural Adjustment Act of 1938, as amended, the acreage which is determined under regulations of the Secretary to have been diverted from the production of wheat under the special programs formulated pursuant to section 307 of this Act, section 339 of the Agricultural Adjustment Act of 1938, as amended, and section 124 of the Agricultural Act of 1961, shall be credited to the State, county, and farm as though such acreage had actually been devoted to the production of wheat. (7 U.S.C. 1339b.)

SEC. 328. Effective with the 1964 crop, during any year in which an acreage diversion program is in effect for feed grains, the Secretary shall, notwithstanding any other provision of law, permit producers of feed grains to have acreage devoted to the production of feed grains considered as devoted to the production of wheat and producers of wheat to have acreage devoted to the production of wheat considered as devoted to the production of feed grains to such extent and subject to such terms and conditions as the Secretary determines will not impair the effective operation of the program for feed grains or wheat. (7 U.S.C. 1339c.)

AGRICULTURAL MARKETING AGREEMENT ACT OF 1937,[1] REENACTING, AMENDING, AND SUPPLEMENTING THE AGRICULTURAL ADJUSTMENT ACT, AS AMENDED

AN ACT

To reenact and amend provisions of the Agricultural Adjustment Act, as amended, relating to marketing agreements and orders.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following provisions of the Agricultural Adjustment Act, as amended, not having been intended for the control of the production of agricultural commodities, and having been intended to be effective irrespective of the validity of any other provision of that Act are expressly affirmed and validated, and are reenacted without change except as provided in section 2:

(a) Section 1 (relating to the declaration of emergency);

DECLARATION

[It is hereby declared that the disruption of the orderly exchange of commodities in interstate commerce impairs the purchasing power of farmers and destroys the value of agricultural assets which support the national credit structure and that these conditions affect transactions in agricultural commodities with a national public interest, and burden and obstruct the normal channels of interstate commerce. (7 U.S.C. 601.)]

(b) Section 2 (relating to declaration of policy);

DECLARATION OF POLICY

[SEC. 2. It is hereby declared to be the policy of Congress—

(1) Through the exercise of the powers conferred upon the Secretary of Agriculture under this title, to establish and maintain such orderly marketing conditions for agricultural commodities in interstate commerce as will establish, as the prices to farmers, parity prices as defined by section 301(a)(1) of the Agricultural Adjustment Act of 1938.[2]

(2) To protect the interest of the consumer by (a) approaching the level of prices which it is declared to be the policy of Congress to establish in subsection (1) of this section by gradual correction of the current level at as rapid a rate as the Secretary of Agriculture deems to be in the public interest and feasible in view of the current consumptive demand in domestic and foreign markets, and (b) authorizing no action under this title which has for its purpose the

[1] Approved June 3, 1937, 50 Stat. 246. This Act reenacted and amended the following sections of Title I of the Agricultural Adjustment Act (of 1933), as amended: 1; 2; 8a(5), (6), (7), (8), (9); 8b; 8c; 8d; 8e; 10(a), (b)(2), (c), (f), (g), (h), (i); 12(a), (c) 14; 22. The language of the provisions (which were reenacted with all amendments up to date of printing) by reference to this Act are set forth in brackets after the appropriate subsections.

[2] Amended by sec. 302 of the Agricultural Act of 1948 (July 3, 1948, 62 Stat. 1247) to refer to parity prices as defined in the Agricultural Adjustment Act of 1938.

maintenance of prices to farmers above the level which it is declared to be the policy of Congress to establish in subsection (1) of this section.

(3) Through the exercise of the power conferred upon the Secretary of Agriculture under this title, to establish and maintain such minimum standards of quality and maturity and such grading and inspection requirements for agricultural commodities enumerated in section 8c(2), other than milk and its products, in interstate commerce as will effectuate such orderly marketing of such agricultural commodities as will be in the public interest.

(4) Through the exercise of the power conferred upon the Secretary of Agriculture under this title, to establish and maintain such orderly marketing conditions for any agricultural commodity enumerated in section 8c(2) as will provide, in the interests of producers and consumers, an orderly flow of the supply thereof to market throughout its normal marketing season to avoid unreasonable fluctuations in supplies and prices.[3]

(5) Through the exercise of the power conferred upon the Secretary of Agriculture under this title, to continue for the remainder of any marketing season or marketing year, such regulation pursuant to any order as will tend to avoid a disruption of the orderly marketing of any commodity and be in the public interest, if the regulation of such commodity under such order has been initiated during such marketing season or marketing year on the basis of its need to effectuate the policy of this title.[4] (7 U.S.C. 602.)]

(c) Section 8a (5), (6), (7), (8), and (9) (relating to violations and enforcement);

VIOLATIONS AND ENFORCEMENT

[SEC. 8a. (5) Any person exceeding any quota or allotment fixed for him under this title by the Secretary of Agriculture and any other person knowingly participating or aiding in the exceeding of such quota or allotment shall forfeit to the United States a sum equal to the value of such excess at the current market price for such commodity at the time of violation, which forfeiture shall be recoverable in a civil suit brought in the name of the United States.[5]

(6) The several district courts of the United States are hereby vested with jurisdiction specifically to enforce, and to prevent and restrain any person from violating any order, regulation, or agreement, heretofore or hereafter made or issued pursuant to this title, in any proceeding now pending or hereafter brought in said courts.

(7) Upon the request of the Secretary of Agriculture, it shall be the duty of the several United States attorneys, in their respective districts, under the directions of the Attorney General, to institute proceedings to enforce the remedies and to collect the forfeitures provided for in, or pursuant to, this title. Whenever the Secretary, or such officer or employee of the Department of Agriculture as he may designate for the purpose, has reason to believe that any handler has violated, or is violating, the provisions of any order or amendment

[3] Subsec. (4) added by sec. 401 of the Agricultural Act of 1954, 68 Stat. 906.
[4] Subsec. (5) added by sec. 141 of the Agricultural Act of 1961 (August 8, 1961, 75 Stat. 303).
[5] Amended by Sec. 141 of the Agricultural Act of 1961 (August 8, 1961, 75 Stat. 304).

thereto issued pursuant to this title, the Secretary shall have power to institute an investigation and, after due notice to such handler, to conduct a hearing in order to determine the facts for the purpose of referring the matter to the Attorney General for appropriate action.

(8) The remedies provided for in this section shall be in addition to, and not exclusive of, any of the remedies or penalties provided for elsewhere in this title or now or hereafter existing at law or in equity.

(9) The term "person" as used in this title includes an individual, partnership, corporation, association, and any other business unit. (7 U.S.C. 608a.)]

(d) Section 8b (relating to marketing agreements);

MARKETING AGREEMENTS

[SEC. 8b. In order to effectuate the declared policy of this title, the Secretary of Agriculture shall have the power, after due notice and opportunity for hearing, to enter into marketing agreements with processors, producers, associations of producers, and others engaged in the handling of any agricultural commodity or product thereof, only with respect to such handling as is in the current of interstate or foreign commerce or which directly burdens, obstructs, or affects, interstate or foreign commerce in such commodity or product thereof. The making of any such agreement shall not be held to be in violation of any of the antitrust laws of the United States, and any such agreement shall be deemed to be lawful: *Provided*, That no such agreement shall remain in force after the termination of this Act. (7 U.S.C. 608b.)]

(e) Section 8c (relating to orders);

ORDERS

[SEC. 8c. (1) The Secretary of Agriculture shall, subject to the provisions of this section, issue, and from time to time amend, orders applicable to processors, associations of producers, and others engaged in the handling of any agricultural commodity or product thereof specified in subsection (2) of this section. Such persons are referred to in this title as "handlers." Such orders shall regulate, in the manner hereinafter in this section provided, only such handling of such agricultural commodity, or product thereof, as is in the current of interstate or foreign commerce, or which directly burdens, obstructs, or affects, interstate or foreign commerce in such commodity or product thereof.

COMMODITIES TO WHICH APPLICABLE

(2) Orders issued pursuant to this section shall be applicable only to (A) the following agricultural commodities and the products thereof (except canned or frozen grapefruit, cherries, apples, or cranberries,[6] the products of naval stores, and the products of honeybees), or to any regional, or market classification of any such commodity or product: Milk, fruits (including filberts, almonds,[7] pecans and walnuts but not including apples, other than apples produced in the

[6] The words "cherries, apples, or cranberries," were added by Sec. 141 of the Agricultural Act of 1961 (August 8, 1961, 75 Stat. 304).

[7] The words "filberts, almonds," were added by the Act of June 29, 1949, 63 Stat. 282.

States of Washington, Oregon, Idaho, New York, Michigan, Maryland, New Jersey, Indiana, California, Maine, Vermont, New Hampshire, Rhode Island, Massachusetts, and Connecticut, and not including fruits for canning or freezing other than olives, grapefruit, cherries, cranberries, and apples produced in the States named above except Washington, Oregon, and Idaho),[8] tobacco, vegetables (not including vegetables, other than asparagus, for canning or freezing), hops, honeybees and naval stores as included in the Naval Stores Act and standards established thereunder (including refined or partially refined oleoresin) : *Provided*, That no order issued pursuant to this section shall be effective as to any grapefruit for canning or freezing unless the Secretary of Agriculture determines, in addition to other findings and determinations required by this Act, that the issuance of such order is approved or favored by the processors who, during a representative period determined by the Secretary, have been engaged in canning or freezing such commodity for market and have canned or frozen for market more than 50 per centum of the total volume of such commodity canned or frozen for market during such representative period; and (B) any agricultural commodity (except honey, cotton, rice, wheat, corn, grain soghums, oats, barley, rye, sugarcane, sugarbeets, wool, mohair, livestock, soybeans, cottonseed, flaxseed, poultry (but not excepting turkeys), eggs (but not excepting turkey hatching eggs), fruits and vegetables for canning or freezing, and apples), or any regional or market classification thereof, not subject to orders under (A) of this paragraph, but not the products (including canned or frozen commodities or products) thereof. No order issued pursuant to this section shall be effective as to cherries, apples, or cranberries for canning or freezing unless the Secretary of Agriculture determines, in addition to other required findings and determinations, that the issuance of such order is approved or favored by processors who, during a representative period determined by the Secretary, have engaged in canning or freezing such commodity for market and have frozen or canned more than 50 per centum of the total volume of the commodity to be regulated which was canned or frozen within the production area, or marketed within the marketing area, defined in such order, during such representative period. No order issued pursuant to this section shall be applicable to peanuts produced in more than one of the following production areas: the Virginia-Carolina production area, the Southeast production area, and the Southwest production area. If the Secretary determines that the declared policy of the title will be better achieved, thereby (i) the commodities of the same general class and used wholly or in part for the same purposes may be combined and treated as a single commodity and (ii) the portion of an agricultural commodity devoted to or marketed for a particular use or combination of uses, may be treated as a separate agricultural commodity. All agricultural commodities and products covered hereby shall be deemed specified herein for the purposes of section 8c (6) and (7) of this title.[9]

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[8] The language referring to the States, other than Idaho, was added by Sec. 141 of the Agricultural Act of 1961 (August 8, 1961, 75 Stat. 304).

[9] Amended by Sec. 141 of the Agricultural Act of 1961 (August 8, 1961, 75 Stat. 304).

NOTICE AND HEARING

(3) Whenever the Secretary of Agriculture has reason to believe that the issuance of an order will tend to effectuate the declared policy of this title with respect to any commodity or product thereof specified in subsection (2) of this section, he shall give due notice of and an opportunity for a hearing upon a proposed order.

FINDING AND ISSUANCE OF ORDER

(4) After such notice and opportunity for hearing, the Secretary of Agriculture shall issue an order if he finds, and sets forth in such order, upon the evidence introduced at such hearing (in addition to such other findings as may be specifically required by the section) that the issuance of such order and all of the terms and conditions thereof will tend to effectuate the declared policy of this title with respect to such commodity.

TERMS—MILK AND ITS PRODUCTS

(5) In the case of milk and its products, orders issued pursuant to this section shall contain one or more of the following terms and conditions, and (except as provided in subsection (7)) no others:

(A) Classifying milk in accordance with the form in which or the purpose for which it is used, and fixing, or providing a method for fixing, minimum prices for each such use classification which all handlers shall pay, and the time when payments shall be made for milk purchased from producers or associations of producers. Such prices shall be uniform as to all handlers, subject only to adjustments for (1) volume, market, and production differentials customarily applied by the handlers subject to such order, (2) the grade or quality of the milk purchased, and (3) the locations at which delivery of such milk, or any use classification thereof, is made to such handlers.

(B) Providing:

(i) for the payment to all producers and associations of producers delivering milk to the same handler of uniform prices for all milk delivered by them: *Provided*, That, except in the case of orders covering milk products only, such provision is approved or favored by at least three-fourths of the producers who, during a representative period determined by the Secretary of Agriculture, have been engaged in the production for market of milk covered in such order or by producers who, during such representative period, have produced at least three-fourths of the volume of such milk produced for market during such period; the approval required hereunder shall be separate and apart from any other approval or disapproval provided for by this section; or

(ii) for the payment to all producers and associations of producers delivering milk to all handlers of uniform prices for all milk so delivered, irrespective of the uses made of such milk by the individual handler to whom it is delivered;

subject, in either case, only to adjustments for (a) volume, market, and production differentials customarily applied by the handlers subject to such order, (b) the grade or quality of the

milk delivered, (c) the locations at which delivery of such milk is made, and (d) a further adjustment, equitably to apportion the total value of the milk purchased by any handler, or by all handlers, among producers and associations of producers, on the basis of their marketings of milk during a representative period of time.

(C) In order to accomplish the purposes set forth in paragraphs (A) and (B) of this subsection (5), providing a method for making adjustments in payments, as among handlers (including producers who are also handlers), to the end that the total sums paid by each handler shall equal the value of the milk purchased by him at the prices fixed in accordance with paragraph (A) hereof.

(D) Providing that, in the case of all milk purchased by handlers from any producer who did not regularly sell milk during a period of 30 days next preceding the effective date of such order for consumption in the area covered thereby, payments to such producer, for the period beginning with the first regular delivery by such producer and continuing until the end of two full calendar months following the first day of the next succeeding calendar month, shall be made at the price for the lowest use classification specified in such order, subject to the adjustments specified in paragraph (B) of this subsection (5).

(E) Providing (i) except as to producers for whom such services are being rendered by a cooperative marketing association, qualified as provided in paragraph (F) of this subsection (5), for market information to producers and for the verification of weights, sampling, and testing of milk purchased from producers, and for making appropriate deductions therefor from payments to producers, and (ii) for assurance of, and security for, the payment by handlers for milk purchased.

(F) Nothing contained in this subsection (5) is intended or shall be construed to prevent a cooperative marketing association qualified under the provisions of the Act of Congress of February 18, 1922, as amended, known as the "Capper-Volstead Act," engaged in making collective sales or marketing of milk or its products for the producers thereof, from blending the net proceeds of all its sales in all markets in all use classifications, and making distribution thereof to its producers in accordance with the contract between the association and its producers: *Provided*, That it shall not sell milk or its products to any handler for use or consumption in any market at prices less than the prices fixed pursuant to paragraph (A) of this subsection (5) for such milk.

(G) No marketing agreement or order applicable to milk and its products in any marketing area shall prohibit or in any manner limit, in the case of the products of milk, the marketing in that area of any milk or product thereof produced in any production area in the United States.

TERMS—OTHER COMMODITIES

(6) In the case of the agricultural commodities and the products thereof, other than milk and its products, specified in subsection

(2) orders issued pursuant to this section shall contain one or more of the following terms and conditions, and (except as provided in subsection (7)), no others: [10]

(A) Limiting, or providing methods for the limitation of, the total quantity of any such commodity or product, or of any grade, size, or quality thereof, produced during any specified period or periods, which may be marketed in or transported to any or all markets in the current of interstate or foreign commerce or so as directly to burden, obstruct, or affect interstate or foreign commerce in such commodity or product thereof, during any specified period or periods by all handlers thereof.

(B) Allotting, or providing methods for allotting, the amount of such commodity or product, or any grade, size, or quality thereof, which each handler may purchase from or handle on behalf of any and all producers thereof, during any specified period or periods, under a uniform rule based upon the amounts sold by such producers in such prior period as the Secretary determines to be representative, or upon the current quantities available for sale by such producers, or both, to the end that the total quantity thereof to be purchased, or handled during any specified period or periods shall be apportioned equitably among producers.

(C) Allotting, or providing methods for allotting, the amount of any such commodity or product, or any grade, size, or quality thereof, which each handler may market in or transport to any or all markets in the current of interstate or foreign commerce or so as directly to burden, obstruct, or affect interstate or foreign commerce in such commodity or product thereof, under a uniform rule based upon the amounts which each such handler has available for current shipment, or upon the amounts shipped by each such handler in such prior period as the Secretary determines to be representative, or both, to the end that the total quantity of such commodity or product, or any grade, size, or quality thereof, to be marketed in or transported to any or all markets in the current of interstate or foreign commerce or so as directly to burden, obstruct, or affect interstate or foreign commerce in such commodity or product thereof, during any specified period or periods shall be equitably apportioned among all of the handlers thereof.

(D) Determining, or providing methods for determining, the existence and extent of the surplus of any such commodity or product, or of any grade, size, or quality thereof, and providing for the control and disposition of such surplus, and for equalizing the burden of such surplus elimination or control among the producers and handlers thereof.

(E) Establishing or providing for the establishment of reserve pools of any such commodity or product, or of any grade, size, or quality thereof, and providing for the equitable distribution of the net return derived from the sale thereof among the persons beneficially interested therein.

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[10] The provisions of this paragraph were substituted for the previous provisions by sec. 401 of the Agricultural Act of 1954, August 28, 1954.

(F) Requiring or providing for the requirement of inspection of any such commodity or product produced during specified periods and marketed by handlers.

(G) In the case of hops and their products, in addition to, or in lieu of, the foregoing terms and conditions, orders may contain one or more of the following:

(i) Limiting, or providing methods for the limitation of, the total quantity thereof, or of any grade, type, or variety thereof, produced during any specified period or periods, which all handlers may handle in the current of or so as directly to burden, obstruct, or affect interstate or foreign commerce in hops or any product thereof.

(ii) Apportioning, or providing methods for apportioning, the total quantity of hops of the production of the then current calendar year permitted to be handled equitably among all producers in the production area to which the order applies upon the basis of one or more or a combination of the following: The total quantity of hops available or estimated will become available for market by each producer from his production during such periods; the normal production of the acreage of hops operated by each producer during such period upon the basis of the number of acres of hops in production, and the average yield of that acreage during such period as the Secretary determines to be representative, with adjustments determined by the Secretary to be proper for age of plantings or abnormal conditions affecting yield; such normal production or historical record of any acreage for which data as to yield of hops are not available or which had no yield during such period shall be determined by the Secretary on the basis of the yields of other acreage of hops of similar characteristics as to productivity, subject to adjustment as just provided for.

(iii) Allotting, or providing methods for allotting, the quantity of hops which any handler may handle so that the allotment fixed for that handler shall be limited to the quantity of hops apportioned under preceding section (ii) to each respective producer of hops; such allotment shall constitute an allotment fixed for that handler within the meaning of subsection (5) of section 8a of this title (U.S.C., 1940 edition, title 7, sec. 608a).

(H) Providing a method for fixing the size, capacity, weight, dimensions, or pack of the container, or containers, which may be used in the packaging, transportation, sale, shipment, or handling of any fresh or dried fruits, vegetables, or tree nuts: *Provided, however*, That no action taken hereunder shall conflict with the Standard Containers Act of 1916 (15 U.S.C. 251–256) and the Standard Containers Act of 1928 (15 U.S.C. 257–257i); [11]

(I) Establishing or providing for the establishment of marketing research and development projects designed to assist, improve, or promote the marketing, distribution, and consumption of any

[11] Added by Sec. 401 of the Agricultural Act of 1954 (68 Stat. 907).

such commodity or product, the expense of such projects to be paid from funds collected pursuant to the marketing order: *Provided*, That with respect to orders applicable to cherries such projects may provide for any form of marketing promotion including paid advertising.[12]

TERMS COMMON TO ALL ORDERS

(7) In the case of the agricultural commodities and the products thereof specified in subsection (2) orders shall contain one or more of the following terms and conditions:

(A) Prohibiting unfair methods of competition and unfair trade practices in the handling thereof.

(B) Providing that (except for milk and cream to be sold for consumption in fluid form) such commodity or product thereof, or any grade, size, or quality thereof shall be sold by the handlers thereof only at prices filed by such handlers in the manner provided in such order.

(C) Providing for the selection by the Secretary of Agriculture, or a method for the selection, of an agency or agencies and defining their powers and duties, which shall include only the powers:

(i) To administer such order in accordance with its terms and provisions;

(ii) To make rules and regulations to effectuate the terms and provisions of such order;

(iii) To receive, investigate, and report to the Secretary of Agriculture complaints of violations of such order; and

(iv) To recommend to the Secretary of Agriculture amendments to such order.

No person acting as a member of an agency established pursuant to this paragraph (C) shall be deemed to be acting in an official capacity, within the meaning of section 10(g) of this title, unless such person receives compensation for his personal services from funds of the United States. There shall be included in the membership of any agency selected to administer a marketing order applicable to grapefruit for canning or freezing one or more representatives of processors of the commodity specified in such order.[13]

(D) Incidental to, and not inconsistent with, the terms and conditions specified in subsections (5), (6) and (7) and necessary to effectuate the other provisions of such order.

ORDERS WITH MARKETING AGREEMENT

(8) Except as provided in subsection (9) of this section, no order issued pursuant to this section shall become effective until the handlers (excluding cooperative associations of producers who are not engaged in processing, distributing, or shipping the commodity or product thereof covered by such order) of not less than 50 per centum of the volume of the commodity or product thereof covered by such

[12] First sentence of Subsec. (I) added by Sec. 403 of the Agricultural Act of 1954 (68 Stat. 907); proviso added by Sec. 403 of the Agricultural Act of 1962 (September 27, 1962, 76 Stat. 632).

[13] This sentence was added by sec. 401 of the Agricultural Act of 1954.

order which is produced or marketed within the production or marketing area defined in such order have signed a marketing agreement, entered into pursuant to section 8b of this title, which regulates the handling of such commodity or product in the same manner as such order, except that as to citrus fruits produced in any area producing what is known as California citrus fruits no order issued pursuant to this subsection (8) shall become effective until the handlers of not less than 80 per centum of the volume of such commodity or product thereof covered by such order have signed such a marketing agreement: *Provided*, That no order issued pursuant to this subsection shall be effective unless the Secretary of Agriculture determines that the issuance of such order is approved or favored:

(A) By at least two-thirds of the producers who (except that as to citrus fruits produced in any area producing what is known as California citrus fruits said order must be approved or favored by three-fourths of the producers), during a representative period determined by the Secretary, have been engaged, within the production area specified in such marketing agreement or order, in the production for market of the commodity specified therein, or who, during such representative period, have been engaged in the production of such commodity for sale in the marketing area specified in such marketing agreement, or order, or

(B) By producers who, during such representative period, have produced for market at least two-thirds of the volume of such commodity produced for market within the production area specified in such marketing agreement or order, or who, during such representative period, have produced at least two-thirds of the volume of such commodity sold within the marketing area specified in such marketing agreement or order.

ORDERS WITH OR WITHOUT MARKETING AGREEMENT

(9) Any order issued pursuant to this section shall become effective in the event that, notwithstanding the refusal or failure of handlers (excluding cooperative associations of producers who are not engaged in processing, distributing, or shipping the commodity or product thereof covered by such order) of more than 50 per centum of the volume of the commodity or product thereof (except that as to citrus fruits produced in any area producing what is known as California citrus fruits said per centum shall be 80 per centum) covered by such order which is produced or marketed within the production or marketing area defined in such order to sign a marketing agreement relating to such commodity or product thereof, on which a hearing has been held, the Secretary of Agriculture, with the approval of the President,[14] determines:

(A) That the refusal or failure to sign a marketing agreement (upon which a hearing has been held) by the handlers (excluding cooperative associations of producers who are not engaged in processing, distributing, or shipping the commodity or product thereof covered by such order) of more than 50 per centum of the volume of the commodity or product thereof (except that as to citrus

[14] 1947 Reorganization Plan No. 1 abolished this function of the President.

fruits produced in any area producing what is known as California citrus fruits said per centum shall be 80 per centum) specific therein which is produced or marketed within the production or marketing area specified therein tends to prevent the effectuation of the declared policy of this title with respect to such commodity or product, and

(B) That the issuance of such order is the only practical means of advancing the interests of the producers of such commodity pursuant to the declared policy and is approved or favored:

(i) By at least two-thirds of the producers (except that as to citrus fruits produced in any area producing what is known as California citrus fruits said order must be approved or favored by three-fourths of the producers) who, during a representative period determined by the Secretary have been engaged within the production area specified in such marketing agreement or order in the production for market of the commodity specified therein, or who, during such representative period, have been engaged in the production of such commodity for sale in the marketing area specified in such marketing agreement, or order, or

(ii) By producers who, during such representative period, have produced for market at least two-thirds of the volume of such commodity produced for market within the production area specified in such marketing agreement or order, or who, during such representative period, have produced at least two-thirds of the volume of such commodity sold within the marketing area specified in such marketing agreement or order.

MANNER OF REGULATION AND APPLICABILITY

(10) No order shall be issued under this section unless it regulates the handling of the commodity or product covered thereby in the same manner as, and is made applicable only to persons in the respective classes of industrial or commercial activity specified in, a marketing agreement upon which a hearing has been held. No order shall be issued under this title prohibiting, regulating, or restricting the advertising of any commodity or product covered thereby, nor shall any marketing agreement contain any provision prohibiting, regulating, or restricting the advertising of any commodity or product covered by such marketing agreement.

REGIONAL APPLICATION

(11) (A) No order shall be issued under this section which is applicable to all production areas or marketing areas, or both, of any commodity or product thereof unless the Secretary finds that the issuance of several orders applicable to the respective regional production areas or regional marketing areas, or both, as the case may be, of the commodity or product would not effectively carry out the declared policy of this title.

(B) Except in the case of milk and its products, orders issued under this section shall be limited in their application to the smallest regional production areas or regional marketing areas, or

both, as the case may be, which the Secretary finds practicable, consistently with carrying out such declared policy.

(C) All orders issued under this section which are applicable to the same commodity or product thereof shall, so far as practicable, prescribe such different terms, applicable to different production areas and marketing areas, as the Secretary finds necessary to give due recognition to the differences in production and marketing of such commodity or product in such areas.

COOPERATIVE ASSOCIATION REPRESENTATION

(12) Whenever, pursuant to the provisions of this section, the Secretary is required to determine the approval or disapproval of producers with respect to the issuance of any order, or any term or condition thereof, or the termination thereof, the Secretary shall consider the approval or disapproval by any cooperative association of producers, bona fide engaged in marketing the commodity or product thereof covered by such order, or in rendering services for or advancing the interests of the producers of such commodity, as the approval or disapproval of the producers who are members of, stockholders in, or under contract with, such cooperative association of producers.

RETAILER AND PRODUCER EXEMPTION

(13) (A) No order issued under subsection (9) of this section shall be applicable to any person who sells agricultural commodities or products thereof at retail in his capacity as such retailer, except to a retailer in his capacity as a retailer of milk and its products.

(B) No order issued under this title shall be applicable to any producer in his capacity as a producer.

VIOLATION OF ORDER

(14) Any handler subject to an order issued under this section, or any officer, director, agent, or employee of such handler, who violates any provision of such order (other than a provision calling for payment of a pro rata share of expenses) shall, on conviction, be fined not less than $50 or more than $500 for each such violation, and each day during which such violation continues shall be deemed a separate violation: *Provided*, That if the court finds that a petition pursuant to subsection (15) of this section was filed and prosecuted by the defendant in good faith and not for delay, no penalty shall be imposed under this subsection for such violations as occurred between the date upon which the defendant's petition was filed with the Secretary, and the date upon which notice of the Secretary's ruling thereon was given to the defendant in accordance with regulations prescribed pursuant to subsection (15).

PETITION BY HANDLER AND REVIEW

(15) (A) Any handler subject to an order may file a written petition with the Secretary of Agriculture, stating that any such order or any provision of any such order or any obligation imposed in connection therewith is not in accordance with law and praying for a modification thereof or to be exempted therefrom.

He shall thereupon be given an opportunity for a hearing upon such petition, in accordance with regulations made by the Secretary of Agriculture, with the approval of the President. After such hearing, the Secretary shall make a ruling upon the prayer of such petition which shall be final, if in accordance with law.

(B) The District Courts of the United States [15] in any district in which such handler is an inhabitant, or has his principal place of business, are hereby vested with jurisdiction in equity to review such ruling, provided a bill in equity for that purpose is filed within twenty days from the date of the entry of such ruling. Service of process in such proceedings may be had upon the Secretary by delivering to him a copy of the bill of complaint. If the court determines that such ruling is not in accordance with law, it shall remand such proceedings to the Secretary with directions either (1) to make such ruling as the court shall determine to be in accordance with law, or (2) to take such further proceedings as, in its opinion, the law requires. The pendency of proceedings instituted pursuant to this subsection (15) shall not impede, hinder, or delay the United States or the Secretary of Agriculture from obtaining relief pursuant to section 8a(6) of this title. Any proceedings brought pursuant to section 8a(6) of this title (except where brought by way of counterclaim in proceedings instituted pursuant to this subsection (15) shall abate whenever a final decree has been rendered in proceedings between the same parties, and covering the same subject matter, instituted pursuant to this subsection (15).

TERMINATION OF ORDERS AND MARKETING AGREEMENTS

(16) (A) The Secretary of Agriculture shall, whenever he finds that any order issued under this section, or any provision thereof, obstructs or does not tend to effectuate the declared policy of this title, terminate or suspend the operation of such order or such provision thereof.

(B) The Secretary shall terminate any marketing agreement entered into under section 8b, or order issued under this section, at the end of the then current marketing period for such commodity, specified in such marketing agreement or order, whenever he finds that such termination is favored by a majority of the producers who, during a representative period determined by the Secretary, have been engaged in the production for market of the commodity specified in such marketing agreement or order, within the production area specified in such marketing agreement or order, or who, during such representative period, have been engaged in the production of such commodity for sale within the marketing area specified in such marketing agreement or order: *Provided*, That such majority have, during such representative period, produced for market more than 50 per centum of the volume of such commodity produced for market within the production area specified in such marketing agreement or order, or have, during such representative period, produced more than 50 per centum of the

[15] The reference to the district court of the United States for the District of Columbia has been deleted as superfluous. See 28 U.S.C. 88, 132a.

volume of such commodity sold in the marketing area specified in such marketing agreement or order, but such termination shall be effective only if announced on or before such date (prior to the end of the then current marketing period) as may be specified in such marketing agreement or order.

(C) The termination or suspension of any order or amendment thereto or provision thereof, shall not be considered an order within the meaning of this section.

PROVISIONS APPLICABLE TO AMENDMENTS

(17) The provisions of this section and section 8d,[16] applicable to orders shall be applicable to amendments to orders: *Provided*, That notice of a hearing upon a proposed amendment to any order issued pursuant to section 8c, given not less than three days prior to the date fixed for such hearing, shall be deemed due notice thereof.

MILK PRICES

(18) The Secretary of Agriculture, prior to prescribing any term in any marketing agreement or order, or amendment thereto, relating to milk or its products, if such term is to fix minimum prices to be paid to producers or associations of producers, or prior to modifying the price fixed in any such term, shall ascertain the parity prices of such commodities. The prices which it is declared to be the policy of Congress to establish in section 2 of this title shall, for the purposes of such agreement, order, or amendment, be adjusted to reflect the price of feeds, the available supplies of feeds, and other economic conditions which affect market supply and demand for milk or its products in the marketing area to which the contemplated marketing agreement, order, or amendment relates. Whenever the Secretary finds, upon the basis of the evidence adduced at the hearing required by section 8b or 8c, as the case may be, that the parity prices of such commodities are not reasonable in view of the price of feeds, the available supplies of feeds, and other economic conditions which affect market supply and demand for milk and its products in the marketing area to which the contemplated agreement, order, or amendment relates, he shall fix such prices as he finds will reflect such factors, insure a sufficient quantity of pure and wholesome milk, and be in the public interest. Thereafter, as the Secretary finds necessary on account of changed circumstances, he shall, after due notice and opportunity for hearing, make adjustments in such prices.[17]

PRODUCER REFERENDUM

(19) For the purpose of ascertaining whether the issuance of an order is approved or favored by producers or processors, as required under the applicable provisions of this title, the Secretary may conduct a referendum among producers or processors and in the case of an order other than an amendatory order shall do so. The requirements of approval or favor under any such provision shall be held to be complied with if, of the total number of producers or processors,

[16] The reference to the old sec. 8e (repealed) was deleted by sec. 302 of the Agricultural Act of 1948 (July 3, 1948, 62 Stat. 1247).

[17] The provisions of this section were substituted for the previous provisions by sec. 302 of the Agricultural Act of 1948 (July 3, 1948, 62 Stat. 1247).

or the total volume of production, as the case may be, represented in such referendum, the percentage approving or favoring is equal to or in excess of the percentage required under such provision. The terms and conditions of the proposed order shall be described by the Secretary in the ballot used in the conduct of the referendum. The nature, content, or extent of such description shall not be a basis for attacking the legality of the order or any action relating thereto. Nothing in this subsection shall be construed as limiting representation by cooperative associations as provided in subsection (12) of this section.[18] (7 U.S.C. 608c.)]

(f) Section 8d (relating to books and records);

BOOKS AND RECORDS

[SEC. 8d. (1) All parties to any marketing agreement, and all handlers subject to an order, shall severally, from time to time, upon the request of the Secretary, furnish him with such information as he finds to be necessary to enable him to ascertain and determine the extent to which such agreement or order has been carried out or has effectuated the declared policy of this title, and with such information as he finds to be necessary to determine whether or not there has been any abuse of the privilege of exemptions from the antitrust laws. Such information shall be furnished in accordance with forms of reports to be prescribed by the Secretary. For the purpose of ascertaining the correctness of any report made to the Secretary pursuant to this subsection, or for the purpose of obtaining the information required in any such report, where it has been requested and has not been furnished, the Secretary is hereby authorized to examine such books, papers, records, copies of income-tax reports, accounts, correspondence, contracts, documents, or memoranda, as he deems relevant and which are within the control (1) of any such party to such marketing agreement, or any such handler, from whom such report was requested or (2) of any person having, either directly or indirectly, actual or legal control of or over such party or such handler or (3) of any subsidiary of any such party, handler, or person.

(2) Notwithstanding the provisions of section 7, all information furnished to or acquired by the Secretary of Agriculture pursuant to this section shall be kept confidential by all officers and employees of the Department of Agriculture and only such information so furnished or acquired as the Secretary deems relevant shall be disclosed by them, and then only in a suit or administrative hearing brought at the direction, or upon the request of the Secretary of Agriculture, or to which he or any officer of the United States is a party, and involving the marketing agreement or order with reference to which the information so to be disclosed was furnished or acquired. Nothing in this section shall be deemed to prohibit (A) the issuance of general statements based upon the reports of a number of parties to a marketing agreement or of handlers subject to an order, which statements do not identify the information furnished by any person, or (B) the publica-

[18] The provisions of this section were substituted for the previous provisions by sec. 141 of the Agricultural Act of 1961 (August 8, 1961, 75 Stat. 345).

tion by direction of the Secretary of the name of any person violating any marketing agreement or any order, together with a statement of the particular provisions of the marketing agreement or order violated by such person. Any such officer or employee violating the provisions of this section shall upon conviction be subject to a fine of not more than $1,000 or to imprisonment for not more than one year, or to both, and shall be removed from office. (7 U.S.C. 608d.)]

(g) Section 8e; [19]

RESTRICTIONS ON IMPORTED COMMODITIES

[SEC. 8e. Notwithstanding any other provision of law, whenever a marketing order issued by the Secretary of Agriculture pursuant to section 8c of this Act contains any terms or conditions regulating the grade, size, quality, or maturity of tomatoes, avocados, mangoes, limes, grapefruit, green peppers, Irish potatoes, cucumbers, oranges, onions, walnuts, dates, or eggplants produced in the United States the importation into the United States of any such commodity, other than dates for processing, during the period of time such order is in effect shall be prohibited unless it complies with the grade, size, quality, and maturity provisions of such order or comparable restrictions promulgated hereunder: *Provided*, That this prohibition shall not apply to such commodities when shipped into continental United States from the Commonwealth of Puerto Rico or any Territory or possession of the United States where this Act has force and effect: *Provided further*, That whenever two or more such marketing orders regulating the same agricultural commodity produced in different areas of the United States are concurrently in effect, the importation into the United States of any such commodity, other than dates for processing, shall be prohibited unless it complies with the grade, size, quality, and maturity provisions of the order which, as determined by the Secretary of Agriculture, regulates the commodity produced in the area with which the imported commodity is in most direct competition. Such prohibition shall not become effective until after the giving of such notice as the Secretary of Agriculture determines reasonable, which shall not be less than three days. In determining the amount of notice that is reasonable in the case of tomatoes the Secretary of Agriculture shall give due consideration to the time required for their transportation and entry into the United States after picking. Whenever the Secretary of Agriculture finds that the application of the restrictions under a marketing order to an imported commodity is not practicable because of variations in characteristics between the domestic and imported commodity he shall establish with respect to the imported commodity, other than dates for processing, such grade, size, quality, and maturity restrictions by varieties, types, or other classifications as he finds will be equivalent or comparable to those imposed upon the domestic commodity under such order. The Secretary of Agriculture may promulgate such rules and regulations as he deems necessary, to carry out the provisions of this section. Any person who violates any provision of this section or of any rule, regulation, or order promulgated hereunder shall be subject to a forfeiture in the

[19] The original provisions of this section were repealed by sec. 302 of the Agricultural Act of 1948 (July 3, 1948, 62 Stat. 1258).

amount prescribed in section 8a(5) or, upon conviction, a penalty in the amount prescribed in section 8c(14) of the Act, or to both such forfeiture and penalty.[20] (7 U.S.C. 608e–1.)]

(h) Section 10(a), (b)(2), (c), (f), (g), (h), and (i) (miscellaneous provisions);

MISCELLANEOUS

[SEC. 10. (a) The Secretary of Agriculture may appoint such officers and employees, subject to the provisions of the Classification Act of 1949[21] and Acts amendatory thereof, and such experts as are necessary to execute the functions vested in him by this title; and the Secretary may make such appointments without regard to the civil service laws or regulations: *Provided*, That no salary in excess of $10,000 per annum shall be paid to any officer, employee, or expert of the Agricultural Adjustment Administration, which the Secretary shall establish in the Department of Agriculture for the administration of the functions vested in him by this title: *And provided further*, That the State Administrator appointed to administer this Act in each State shall be appointed by the President, by and with the advice and consent of the Senate. Title II of the Act entitled "An Act to maintain the credit of the United States Government", approved March 20, 1933, to the extent that it provides for the impoundment of appropriations on account of reductions in compensation, shall not operate to require such impoundment under appropriations contained in this Act.

(b)(1) The Secretary of Agriculture is authorized to establish, for the more effective administration of the functions vested in him by this title, State and local committees, or associations of producers, and to permit cooperative associations of producers, when in his judgment they are qualified to do so, to act as agents of their members and patrons in connection with the distribution of payments authorized to be made under section 8. The Secretary, in the administration of this title shall accord such recognition and encouragement to producer-owned and producer-controlled cooperative associations as will be in harmony with the policy toward cooperative associations set forth in existing Acts of Congress, and as will tend to promote efficient methods of marketing and distribution.

(2)(i) Each order relating to milk and its products issued by the Secretary under this title shall provide that each handler subject thereto shall pay to any authority or agency established under such order such handler's pro rata share (as approved by the Secretary) of such expenses as the Secretary may find will necessarily be incurred by such authority or agency, during any period specified by him, for the maintenance and functioning of such authority or agency, other than expenses incurred in receiving, handling, holding, or dispos-

[20] The provisions of this section were substituted for the previous provisions by sec. 141 of the Agricultural Act of 1961 (August 8, 1961, 75 Stat. 305).
[21] "1949" substituted for "1923" by the Act of October 28, 1949, 63 Stat. 972.

ing of any quantity of milk or products thereof received, handled, held, or disposed of by such authority or agency for the benefit or account of persons other than handlers subject to such order. The pro rata share of the expenses payable by a cooperative association of producers shall be computed on the basis of the quantity of milk or product thereof covered by such order which is distributed, processed, or shipped by such cooperative association of producers.

(ii) Each order relating to any other commodity or product issued by the Secretary under this title shall provide that each handler subject thereto shall pay to any authority or agency established under such order such handler's pro rata share (as approved by the Secretary) of such expenses as the Secretary may find are reasonable and are likely to be incurred by such authority or agency, during any period specified by him, for such purposes as the Secretary may, pursuant to such order, determine to be appropriate, and for the maintenance and functioning of such authority or agency, other than expenses incurred in receiving, handling, holding, or disposing of any quantity of a commodity received, handled, held, or disposed of by such authority or agency for the benefit or account of persons other than handlers subject to such order. The pro rata share of the expenses payable by a cooperative association of producers shall be computed on the basis of the quantity of the agricultural commodity or product thereof covered by such order which is distributed, processed, or shipped by such cooperative association of producers. The payment of assessments for the maintenance and functioning of such authority or agency, as provided for herein, may be required under a marketing agreement or marketing order throughout the period the marketing agreement or order is in effect and irrespective of whether particular provisions thereof are suspended or become inoperative.

(iii) Any authority or agency established under an order may maintain in its own name, or in the name of its members, a suit against any handler subject to an order for the collection of such handler's pro rata share of expenses. The several district courts of the United States are hereby vested with jurisdiction to entertain such suits regardless of the amount in controversy.

(c) The Secretary of Agriculture is authorized, with the approval of the President, to make such regulations with the force and effect of law as may be necessary to carry out the powers vested in him by this title. Any violation of any regulations shall be subject to such penalty, not in excess of $100, as may be provided therein.

* * * * * * *

(f) The provisions of this title shall be applicable to the United States and its possessions, except the Philippine Islands, the Virgin Islands, American Samoa, the Canal Zone, and the island of Guam; except that, in the case of sugarbeets and sugarcane, the President, if he finds it necessary in order to effectuate the declared policy of

this Act, is authorized by proclamation to make the provisions of this title applicable to the Philippine Islands, the Virgin Islands, American Samoa, the Canal Zone, and/or the island of Guam.

(g) No person shall, while acting in any official capacity in the administration of this title, speculate, directly or indirectly, in any agricultural commodity or product thereof, to which this title applies, or in contracts relating thereto, or in the stock or membership interests of any association or corporation engaged in handling, processing, or disposing of any such commodity or product. Any person violating this subsection shall upon conviction thereof be fined not more than $10,000 or imprisoned not more than two years, or both.

(h) For the efficient administration of the provisions of part 2 of this title, the provisions, including penalties, of sections 8, 9, and 10 of the Federal Trade Commission Act, approved September 26, 1914, are made applicable to the jurisdiction, powers, and duties of the Secretary in administering the provisions of this title and to any person subject to the provisions of this title, whether or not a corporation. Hearings authorized or required under this title shall be conducted by the Secretary of Agriculture or such officer or employee of the Department as he may designate for the purpose. The Secretary may report any violation of any agreement entered into under part 2 of this title of the Attorney General of the United States, who shall cause appropriate proceedings to enforce such agreement to be commenced and prosecuted in the proper courts of the United States without delay.

(i) The Secretary of Agriculture upon the request of the duly constituted authorities of any State is directed, in order to effectuate the declared policy of this title and in order to obtain uniformity in the formulation, administration, and enforcement of Federal and State programs relating to the regulation of the handling of agricultural commodities or products thereof, to confer with and hold joint hearings with the duly constituted authorities of any State, and is authorized to cooperate with such authorities; to accept and utilize, with the consent of the State, such State and local officers and employees as may be necessary; to avail himself of the records and facilities of such authorities; to issue orders (subject to the provisions of section 8c) complementary to orders or other regulations issued by such authorities; and to make available to such State authorities the records and facilities of the Department of Agriculture: *Provided*, That information furnished to the Secretary of Agriculture pursuant to section 8d(1) hereof shall be made available only to the extent that such information is relevant to transactions within the regulatory jurisdiction of such authorities, and then only upon a written agreement by such authorities that the information so furnished shall be kept confidential by them in a manner similar to that required of Federal officers and employees under the provisions of section 8d(2) hereof.

(j) The term "interstate or foreign commerce" means commerce between any State, Territory, or possession, or the District of Columbia, and any place outside thereof; or between points within the same State, Territory, or possession, or the District of Columbia, but through any place outside thereof; or within any Territory or posses-

sion, or the District of Columbia. For the purpose of this Act (but in nowise limiting the foregoing definition) a marketing transaction in respect to an agricultural commodity or the product thereof shall be considered in interstate or foreign commerce if such commodity or product is part of that current of interstate or foreign commerce usual in the handling of the commodity or product whereby they, or either of them, are sent from one State to end their transit, after purchase, in another, including all cases where purchase or sale is either for shipment to another State or for the processing within the State and the shipment outside the State of the products so processed. Agricultural commodities or products thereof normally in such current of interstate or foreign commerce shall not be considered out of such current through resort being had to any means or device intended to remove transactions in respect thereto from the provisions of this Act. As used herein the word "State" includes Territory, the District of Columbia, possession of the United States, and foreign nations.[22] (7 U.S.C. 610.)]

(i) Section 12 (a) and (c) (relating to appropriation and expense);

APPROPRIATION

[SEC. 12. (a) There is hereby appropriated, out of any money in the Treasury not otherwise appropriated, the sum of $100,000,000 to be available to the Secretary of Agriculture for administrative expenses under this title and for payments authorized to be made under section 8. Such sum shall remain available until expended.

To enable the Secretary of Agriculture to finance, under such terms and conditions as he may prescribe, surplus reductions with respect to the dairy- and beef-cattle industries, and to carry out any of the purposes described in subsections (a) and (b) of this section (12) and to support and balance the markets for the dairy and beef cattle industries, there is authorized to be appropriated, out of any money in the Treasury not otherwise appropriated, the sum of $200,000,000; *Provided*, That not more than 60 per centum of such amount shall be used for either of such industries.

* * * * * * *

(c) The administrative expenses provided for under this section shall include, among others, expenditures for personal services and rent in the District of Columbia and elsewhere, for law books and books of reference, for contract stenographic reporting services, and for printing and paper in addition to allotments under the existing law. The Secretary of Agriculture shall transfer to the Treasury Department, and is authorized to transfer to other agencies, out of funds available for administrative expenses under this title, such sums as are required to pay administrative expenses incurred and refunds made by such department or agencies in the administration of this title. (7 U.S.C. 612.)]

(j) Section 14 (relating to separability);

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[22] Par. (j) added by sec 2(i) of the Agricultural Act of 1937 (June 3, 1937, 50 Stat. 248).

SEPARABILITY OF PAYMENTS

[SEC. 14. If any provision of this title is declared unconstitutional, or the applicability thereof to any person, circumstance, or commodity is held invalid the validity of the remainder of this title and the applicability thereof to other persons, circumstances, or commodities shall not be affected thereby. (7 U.S.C. 714.)]

(k) Section 22 (relating to imports);

[SEC. 22 appears on p. 284 of this compilation.]

AMENDMENTS TO AGRICULTURAL ADJUSTMENT ACT

SEC. 2. The following provisions, reenacted in section 1 of this Act, are amended as follows:

[Subsecs. (a) to (j) inclusive, of sec. 2 of the Agricultural Marketing Agreement Act of 1937 are incorporated in the preceding text and in the footnotes.]

ARBITRATION OF DISPUTES CONCERNING MILK

SEC. 3. (a) The Secretary of Agriculture, or such officer or employee of the Department of Agriculture as may be designated by him, upon written application of any cooperative association, incorporated or otherwise, which is in good faith owned or controlled by producers or organizations thereof, of milk or its products, and which is bona fide engaged in collective processing or preparing for market or handling or marketing (in the current of interstate or foreign commerce, as defined by paragraph (i) of section 2 of this Act), milk or its products, may mediate and, with the consent of all parties, shall arbitrate if the Secretary has reason to believe that the declared policy of the Agricultural Adjustment Act, as amended, would be effectuated thereby, bona fide disputes, between such associations and the purchasers or handlers or processors or distributors of milk or its products, as to terms and conditions of the sale of milk or its products. The power to arbitrate under this section shall apply only to such subjects of the term or condition in dispute as could be regulated under the provisions of the Agricultural Adjustment Act, as amended, relating to orders for milk and its products.

(b) Meetings held pursuant to this section shall be conducted subject to such rules and regulations as the Secretary may prescribe.

(c) No award or agreement resulting from any such arbitration or mediation shall be effective unless and until approved by the Secretary of Agriculture, or such officer or employee of the Department of Agriculture as may be designated by him, and shall not be approved if it permits any unlawful trade practice or any unfair method of competition.

(d) No meeting so held and no award or agreement so approved shall be deemed to be in violation of any of the antitrust laws of the United States. (7 U.S.C. 671.)

AGREEMENTS, ETC., UNAFFECTED

SEC. 4. (a) Nothing in this act shall be construed as invalidating any marketing agreement, license, or order, or any regulation relating to, or any provision of, or any act of the Secretary of Agriculture in connection with, any such agreement, license, or order which has been executed, issued, approved, or done under the Agricultural Ad-

justment Act, or any amendment thereof, but such marketing agreements, licenses, orders, regulations, provisions, and acts are hereby expressly ratified, legalized, and confirmed.

(b) Any program in effect under the Agricultural Adjustment Act, as reenacted and amended by this Act, on the effective date of section 302 of the Agricultural Act of 1948 shall continue in effect without the necessity for any amendatory action relative to such program, but any such program shall be continued in operation by the Secretary of Agriculture only to establish and maintain such orderly marketing conditions as will tend to effectuate the declared purpose set out in section 2 or 8c (18) of the Agricultural Adjustment Act, as reenacted and amended by this Act.[23] (7 U.S.C. 672.)

TAXES UNDER AGRICULTURAL ADJUSTMENT ACT; PROVISIONS UNAFFECTED

SEC. 5. No processing taxes or compensating taxes shall be levied or collected under the Agricultural Adjustment Act, as amended. Except as provided in the preceding sentence, nothing in this Act shall be construed as affecting provisions of the Agricultural Adjustment Act, as amended, other than those enumerated in section 1. The provisions so enumerated shall apply in accordance with their terms (as amended by this Act) to the provisions of the Agricultural Adjustment Act, this Act, and other provisions of law to which they have been heretofore made applicable. (7 U.S.C. 673.)

SHORT TITLE

SEC. 6. This act may be cited as the "Agricultural Marketing Agreement Act of 1937." (7 U.S.C. 674.)

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[23] Sec. 302 of the Agricultural Act of 1948 (62 Stat. 1247) inserted the subsection designation (a) and added subsec. (b).

NATIONAL SCHOOL LUNCH ACT[1]

AN ACT

To provide assistance to the States in the establishment, maintenance, operation, and expansion of school-lunch programs, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National School Lunch Act." (42 U.S.C. 1751 note.)

DECLARATION OF POLICY

SEC. 2. It is hereby declared to be the policy of Congress, as a measure of national security, to safeguard the health and well-being of the Nation's children and to encourage the domestic consumption of nutritious agricultural commodities and other food, by assisting the States, through grants-in-aid and other means, in providing an adequate supply of foods and other facilities for the establishment, maintenance, operation, and expansion of nonprofit school-lunch programs. (42 U.S.C. 1751.)

APPROPRIATIONS AUTHORIZED

SEC. 3.[2] For each fiscal year there is hereby authorized to be appropriated, out of money in the Treasury not otherwise appropriated, such sums as may be necessary to enable the Secretary of Agriculture (hereinafter referred to as "the Secretary") to carry out the provisions of this Act, other than section 11. (42 U.S.C. 1752.)

APPORTIONMENTS TO STATES

SEC. 4.[3] The sums appropriated for any fiscal year pursuant to the authorization contained in section 3 of this Act, excluding the sum specified in section 5, shall be available to the Secretary for supplying agricultural commodities and other foods for the program in accordance with the provisions of this Act. The Secretary shall apportion among the States during each fiscal year not less than 75 percentum of the funds made available for such year for supplying agricultural commodities and other foods under the provisions of section 3 of this Act. Apportionment among the States shall be made upon the basis of two factors: (1) the participation rate for the State, and (2) the assistance need rate for the State. The amount of apportionment to any State shall be determined by the following method: First, determine an index for the State by multiplying factors (1) and (2); second, divide this index by the sum of the indices for all the States (exclusive of American Samoa for periods

[1] June 4, 1946, 60 Stat. 230. See also Act of July 1, 1958, as amended (7 U.S.C. 1446 note) (relating to use of Commodity Credit Corporation funds to increase milk consumption in schools (p. 218) and sec. 404 (relating to utilizing Commodity Credit Corporation in carrying out school lunch programs) (p. 159) of the Agricultural Act of 1949.

[2] Sec. 3 was amended by Pub. L. 87–823, October 15, 1962.

[3] Sec. 4 was amended by the Act of October 15, 1962, 76 Stat. 944.

ending before July 1, 1967); and third, apply the figure thus obtained to the total funds to be apportioned. If any State cannot utilize all funds so apportioned to it, or if additional funds are made available under section 3 for apportionment among the States, the Secretary shall make further apportionments to the remaining States in the same manner. Notwithstanding the foregoing provisions of this section, (1) for the fiscal year beginning July 1, 1962, three-quarters of any funds available for apportionment among the States shall be apportioned in the manner used prior to such fiscal year, and one-quarter of any such funds shall be apportioned in accordance with the foregoing sentences of this section, (2) for the fiscal year beginning July 1, 1963, one-half of any funds available for apportionment among the States shall be apportioned in the manner used prior to the fiscal year beginning July 1, 1962, and one-half of any such funds shall be apportioned in accordance with the foregoing sentences of this section, (3) for the fiscal year beginning July 1, 1964, one-quarter of any funds available for apportionment among the States shall be apportioned in the manner used prior to the fiscal year beginning July 1, 1962, and three-quarters of any such funds shall be apportioned in accordance with the foregoing sentences of this section, and (4) for the five fiscal years in the period beginning July 1, 1962, and ending June 30, 1967, the amount apportioned to American Samoa shall be $25,000 each year, which amount shall be first deducted from the funds available for apportionment in determining the amounts to be apportioned to the other States. (42 U.S.C. 1753.)

NONFOOD ASSISTANCE

SEC. 5.[4] Of the sums appropriated for any fiscal year pursuant to the authorization contained in section 3 of this Act, $10,000,000 shall be available to the Secretary for the purpose of providing, during such fiscal year, nonfood assistance for the school-lunch program pursuant to the provisions of this Act. The Secretary shall apportion among the States during each fiscal year the aforesaid sum of $10,000,000, and such apportionment among the States shall be on the basis of the factors, and in accordance with the standards, set forth in section 4 with respect to the apportionment for agricultural commodities and other foods. (42 U.S.C. 1754.)

DIRECT FEDERAL EXPENDITURES

SEC. 6. The funds appropriated for any fiscal year for carrying out the provisions of this Act, less not to exceed 3½ per centum thereof hereby made available to the Secretary for his administrative expenses, less the amount apportioned by him pursuant to sections 4, 5, and 10, and less the amount appropriated pursuant to section 11,[5] shall be available to the Secretary during such year for direct expenditure by him for agricultural commodities and other foods to be distributed among the States and schools participating in the school-lunch program under this Act in accordance with the needs as determined by the local school authorities. The provisions of law contained in the proviso of the Act of June 28, 1937 (50 Stat. 323), facilitating

[4] This section amended by the Act of October 15, 1962 (Pub. L. 87–823) 76 Stat. 945.
[5] Preceding clause added by the Act of October 15, 1962 (Pub. L. 87–823), 76 Stat. 945.

operations with respect to the purchase and disposition of surplus agricultural commodities under section 32 of the Act approved August 24, 1935 (49 Stat. 774), as amended, shall, to the extent not inconsistent with the provisions of this Act, also be applicable to expenditures of funds by the Secretary under this Act. (42 U.S.C. 1755.)

PAYMENTS TO STATES

SEC. 7. Funds apportioned to any State pursuant to section 4 or 5 during any fiscal year shall be available for payment to such State for disbursement by the State educational agency, in accordance with such agreements not inconsistent with the provisions of this Act, as may be entered into by the Secretary and such State educational agency, for the purpose of assisting schools of that State during such fiscal year, in supplying (1) agricultural commodities and other foods for consumption by children and (2) nonfood assistance in furtherance of the school-lunch program authorized under this Act. Such payments to any State in any fiscal year during the period 1947 to 1950, inclusive, shall be made upon condition that each dollar thereof will be matched during such year by $1 from sources within the State determined by the Secretary to have been expended in connection with the school-lunch program under this Act. Such payments in any fiscal year during the period 1951 to 1955, inclusive, shall be made upon condition that each dollar thereof will be so matched by one and one-half dollars; and for any fiscal year thereafter, such payments shall be made upon condition that each dollar will be so matched by $3. In the case of any State whose per capita income is less than the per capita income of the United States, the matching required for any fiscal year shall be decreased by the percentage which the State per capita income is below the per capita income of the United States. For the purpose of determining whether the matching requirements of this section and section 10, respectively, have been met, the reasonable value of donated services, supplies, facilities, and equipment as certified, respectively, by the State educational agency and in case of schools receiving funds pursuant to section 10, by such schools (but not the cost or value of land, of the acquisition, construction, or alteration of buildings of commodities donated by the Secretary, or of Federal contributions), may be regarded as funds from sources within the State expended in connection with the school-lunch program. The Secretary shall certify to the Secretary of the Treasury from time to time the amounts to be paid to any State under this section and the time or times such amounts are to be paid; and the Secretary of the Treasury shall pay to the State at the time or times fixed by the Secretary the amounts so certified. (42 U.S.C. 1756.)

STATE DISBURSEMENT TO SCHOOLS

SEC. 8. Funds paid to any State during any fiscal year pursuant to section 4 or 5 shall be disbursed by the State educational agency, in accordance with such agreements approved by the Secretary as may be entered into by such State agency and the schools in the State, to those schools in the State which the State educational agency, taking into account need and attendance, determines are eligible to partici-

pate in the school-lunch program. Such disbursement to any school shall be made only for the purpose of reimbursing it for the cost of obtaining agricultural commodities and other foods for consumption by children in the school-lunch program and nonfood assistance in connection with such program. Such food costs may include, in addition to the purchase price of agricultural commodities and other foods, the cost of processing, distributing, transporting, storing, or handling thereof. In no event shall such disbursement for food to any school for any fiscal year exceed an amount determined by multiplying the number of lunches served in the school in the school-lunch program under this Act during such year by the maximum Federal food-cost contribution rate for the State, for the type of lunch served, as prescribed by the Secretary. (42 U.S.C. 1757.)

NUTRITIONAL AND OTHER PROGRAM REQUIREMENTS

SEC. 9. Lunches served by schools participating in the school-lunch program under this Act shall meet minimum nutritional requirements prescribed by the Secretary on the basis of tested nutritional research. Such meals shall be served without cost or at a reduced cost to children who are determined by local school authorities to be unable to pay the full cost of the lunch. No physical segregation of or other discrimination against any child shall be made by the school because of his inability to pay. School-lunch programs under this Act shall be operated on a nonprofit basis. Each school shall, insofar as practicable, utilize in its lunch program commodities designated from time to time by the Secretary as being in abundance, either nationally or in the school area, or commodities donated by the Secretary. Commodities purchased under the authority of section 32 of the Act of August 24, 1935 (49 Stat. 774), as amended, may be donated by the Secretary to schools, in accordance with the needs as determined by local school authorities, for utilization in the school-lunch program under this Act as well as to other schools carrying out nonprofit school-lunch programs and institutions authorized to receive such commodities. (42 U.S.C. 1758.)

NONPROFIT PRIVATE SCHOOLS

SEC. 10. If, in any State, the State educational agency is not permitted by law to disburse the funds paid to it under this Act to nonprofit private schools in the State, or is not permitted by law to match Federal funds made available for use by such nonprofit private schools, the Secretary shall withhold from the funds apportioned to any such State under sections 4 and 5 of this Act an amount which bears the same ratio to such funds as the number of lunches, consisting of a combination of foods and meeting the minimum requirements prescribed by the Secretary pursuant to section 9, served in the preceding fiscal year by all nonprofit private schools participating in the program under this Act within the State, as determined by the Secretary, bears to the participation rate for the State.[6] The Secretary shall disburse the funds so withheld directly to the nonprofit private schools within said State for the same purposes and subject to the same conditions as are authorized or required with respect to

[6] Provisions of this sentence substituted for the previous provisions by the Act of October 15, 1962 (Pub. L. 87–823), 76 Stat. 945.

the disbursements to schools within the State by the State educational agency, including the requirement that any such payment or payments shall be matched, in the proportion specified in section 7 for such State, by funds from sources within the State expended by nonprofit private schools within the State participating in the school-lunch program under this Act. Such funds shall not be considered a part of the funds constituting the matching funds under the terms of section 7. (42 U.S.C. 1759.)

SPECIAL ASSISTANCE

SEC. 11.[7] (a) There is hereby authorized to be appropriated $10,000,000 for the fiscal year ending June 30, 1963, and such sums as may be necessary for each succeeding fiscal year to provide special assistance to schools drawing attendance from areas in which poor economic conditions exist, for the purpose of helping such schools to meet the requirement of section 9 of this Act concerning the service of lunches to children unable to pay the full cost of such lunches.

(b) Of the sums appropriated pursuant to this section for any fiscal year, 3 per centum shall be available for apportionment to Puerto Rico, the Virgin Islands, Guam, and American Samoa. From the funds so available the Secretary shall apportion to each such State an amount which bears the same ratio to the total of such funds as the number of free or reduced-price lunches served in accordance with section 9 of this Act in such State in the preceding fiscal year bears to the total number of such free or reduced-price lunches served in all such States in the preceding fiscal year: *Provided*, That for the fiscal year ending June 30, 1963, $5,000 shall be apportioned to American Samoa, which amount shall be first deducted from the total amount available for apportionment under this subsection. If any such State cannot utilize for the purposes of this section all of the funds apportioned to it the Secretary shall make further apportionment on the same basis as the initial apportionment to any such States which justify the need for additional funds for such purposes.

(c) Of the remaining sums appropriated pursuant to this section for any fiscal year, not less than 50 per centum shall be apportioned among States, other than Puerto Rico, the Virgin Islands, Guam, and American Samoa, on the basis of the following factors for each State: (1) the number of free or reduced-price lunches served in accordance with section 9 of this Act in the preceding fiscal year, and (2) the assistance need rate. These factors shall be applied in the following manner: First, determine an index for each State by multiplying factors (1) and (2); second, divide this index by the sum of the indices for all such States; and, third, apply the figure thus obtained to the total funds to be apportioned. Any funds so initially apportioned which cannot be used for the purpose of this section by the State to which apportioned, together with the remainder of the funds available under this subsection, shall be further apportioned by the Secretary on the same basis as the initial apportionment to such States which justify on the basis of operating experience the

[7] This section inserted by the Act of October 15, 1962 (Pub. L. 87–823), 76 Stat. 946. Former section 11 became the present section 12, as amended.

need for additional funds to meet the need of students in such States for free or reduced-price lunches in schools deemed eligible by their State educational agencies for special assistance in accordance with the factors set forth in subsection (e) of this section.

(d) Payment of the funds apportioned to any State under this section shall be made as provided in the last sentence of section 7 of the Act.

(e) Funds paid to any State during any fiscal year pursuant to this section shall be disbursed to selected schools in such State to assist such schools in the purchase of agricultural commodities and other foods. The selection of schools and the amounts of funds that each shall from time to time receive (within a maximum per lunch amount established by the Secretary for all the States) shall be determined by the State educational agency on the basis of the following factors: (1) The economic condition of the area from which such schools draw attendance; (2) the needs of pupils in such schools for free or reduced-price lunches; (3) the percentages of free and reduced-price lunches being served in such schools to their pupils; (4) the prevailing price of lunches in such schools as compared with the average prevailing price of lunches served in the State under this Act; and (5) the need of such schools for additional assistance as reflected by the financial position of the school lunch programs in such schools.

(f) If in any State the State educational agency is not permitted by law to disburse funds paid to it under this Act to nonprofit private schools in the State, the Secretary shall withhold from the funds apportioned to such State under subsections (b) or (c) of this section an amount which bears the same ratio to such funds as the number of free and reduced-price lunches served in accordance with section 9 of this Act in the preceding fiscal year by all nonprofit private schools participating in the program under this Act in such State bears to the number of such free and reduced-price lunches served during such year by all schools participating in the program under this Act in such State. The Secretary shall disburse the funds so withheld directly to the nonprofit private schools within such State for the same purposes and subject to the same conditions as are applicable to a State educational agency disbursing funds under this section.

(g) In carrying out this section, the terms and conditions governing the operation of the school lunch program set forth in other sections of this Act, including those applicable to funds apportioned or paid pursuant to sections 4 or 5 but excluding the provisions of section 7 relating to matching, shall be applicable to the extent they are not inconsistent with the express requirements of this section. (42 U.S.C. 1759a.)

MISCELLANEOUS PROVISIONS AND DEFINITIONS

SEC. 12.[8] (a) States, State educational agencies, and schools participating in the school-lunch program under this Act shall keep such accounts and records as may be necessary to enable the Secretary to

[8] This section was previously section 11. Subsections (d) (1) through (4) were amended, and subsections (d) (5) and (6) added, by the Act of October 15, 1962 (Pub. L. 87-823) 76 Stat. 947.

determine whether the provisions of this Act are being complied with. Such accounts and records shall at all times be available for inspection and audit by representatives of the Secretary and shall be preserved for such period of time, not in excess of five years, as the Secretary determines is necessary.

(b) The Secretary shall incorporate, in his agreements with the State educational agencies, the express requirements under this Act with respect to the operation of the school-lunch program under this Act insofar as they may be applicable and such other provisions as in his opinion are reasonably necessary or appropriate to effectuate the purposes of this Act.

(c) In carrying out the provisions of this Act, neither the Secretary nor the State shall impose any requirement with respect to teaching personnel, curriculum, instruction, methods of instruction, and materials of instruction in any school.

(d) For the purposes of this Act—

(1) "State" means any of the fifty States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, or American Samoa.

(2) "State educational agency" means, as the State legislature may determine, (A) the chief State school officer (such as the State superintendent of public instruction, commissioner of education, or similar officer), or (B) a board of education controlling the State department of education; except that in the District of Columbia it shall mean the Board of Education.

(3) "Nonprofit private school" means any private school exempt from income tax under section 501(c)(3) of the Internal Revenue Code of 1954.

(4) "Nonfood assistance" means equipment used by schools in storing, preparing, or serving food for school children.

(5) "Participation rate" for a State means a number equal to the number of lunches, consisting of a combination of foods and meeting the minimum requirements prescribed by the Secretary pursuant to section 9, served in the preceding fiscal year by schools participating in the program under this Act in the State, as determined by the Secretary.

(6) "Assistance need rate" (A) in the case of any State having an average annual per capita income equal to or greater than the average annual per capita income for all the States, shall be 5; and (B) in the case of any State having an average annual per capita income less than the average annual per capita income for all the States, shall be the product of 5 and the quotient obtained by dividing the average annual per capita income for all the States by the average annual per capita income for such State, except that such product may not exceed 9 for any such State. For the purposes of this paragraph (i) the average annual per capita income for any State and for all the States shall be determined by the Secretary on the basis of the average annual per capita income for each State and for all the States for the three most recent years for which such data are available and certified to the Secretary by the Department of Commerce; and (ii) the average annual per capita income for American Samoa shall be

758-820—65——22

disregarded in determining the average annual per capita income for all the States for periods ending before July 1, 1967.

(7) "School" means any public or nonprofit private school of high school grade or under and, with respect to Puerto Rico, shall also include nonprofit child-care centers certified as such by the Governor of Puerto Rico. (42 U.S.C. 1760.)

FOOD STAMP ACT OF 1964[1]

AN ACT

To strengthen the agricultural economy; to help to achieve a fuller and more effective use of food abundances; to provide for improved levels of nutrition among low-income households through a cooperative Federal-State program of food assistance to be operated through normal channels of trade; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as "The Food Stamp Act of 1964".

DECLARATION OF POLICY

SEC. 2. It is hereby declared to be the policy of Congress, in order to promote the general welfare, that the Nation's abundance of food should be utilized cooperatively by the States, the Federal Government, and local governmental units to the maximum extent practicable to safeguard the health and well-being of the Nation's population and raise levels of nutrition among low-income households. The Congress hereby finds that increased utilization of foods in establishing and maintaining adequate national levels of nutrition will tend to cause the distribution in a beneficial manner of our agricultural abundances and will strengthen our agricultural economy, as well as result in more orderly marketing and distribution of food. To effectuate the policy of Congress and the purposes of this Act, a food stamp program, which will permit those households with low incomes to receive a greater share of the Nation's food abundance, is herein authorized. (7 U.S.C. 2011.)

DEFINITIONS

SEC. 3. As used in this Act—

(a) The term "Secretary" means the Secretary of Agriculture.

(b) The term "food" means any food or food product for human consumption except alcoholic beverages, tobacco, those foods which are identified on the package as being imported, and meat and meat products which are imported.

(c) The term "coupon" means any coupon, stamp, or type of certificate issued pursuant to the provisions of this Act.

(d) The term "coupon allotment" means the total value of coupons to be issued to a household during each month or other time period.

(e) The term "household" shall mean a group of related or nonrelated individuals, who are not residents of an institution or boarding house, but are living as one economic unit sharing common cooking facilities and for whom food is customarily purchased in common. The term "household" shall also mean a single individual living alone who has cooking facilities and who purchases and prepares food for home consumption.

[1] Pub. L. 88–525, 78 Stat. 703, approved August 31, 1964.

(f) The term "retail food store" means an establishment, including a recognized department thereof, or a house-to-house trade route which sells food to households for home consumption.

(g) The term "wholesale food concern" means an establishment which sells food to retail food stores for resale to households.

(h) The term "State agency" means the agency of the State government which has responsibility for the administration of the federally aided public assistance programs.

(i) The term "bank" means member or nonmember banks of the Federal Reserve System.

(j) The term "State" means the fifty States and the District of Columbia.

(k) The term "food stamp program" means any program promulgated pursuant to the provisions of this Act. (7 U.S.C. 2012.)

ESTABLISHMENT OF THE FOOD STAMP PROGRAM

SEC. 4. (a) The Secretary is authorized to formulate and administer a food stamp program under which, at the request of an appropriate State agency, eligible households within the State shall be provided with an opportunity more nearly to obtain a nutritionally adequate diet through the issuance to them of a coupon allotment which shall have a greater monetary value than their normal expenditures for food. The coupons so received by such households shall be used only to purchase food from retail food stores which have been approved for participation in the food stamp program. Coupons issued and used as provided in this Act shall be redeemable at face value by the Secretary through the facilities of the Treasury of the United States.

(b) In areas where a food stamp program is in effect, there shall be no distribution of federally owned foods to households under the authority of any other law except during emergency situations caused by a national or other disaster as determined by the Secretary.

(c) The Secretary shall issue such regulations, not inconsistent with this Act, as he deems necessary or appropriate for the effective and efficient administration of the food stamp program. (7 U.S.C. 2013.)

ELIGIBLE HOUSEHOLDS

SEC. 5. (a) Participation in the food stamp program shall be limited to those households whose income is determined to be a substantial limiting factor in the attainment of a nutritionally adequate diet.

(b) In complying with the limitation on participation set forth in subsection (a) above, each State agency shall establish standards to determine the eligibility of applicant households. Such standards shall include maximum income limitations consistent with the income standards used by the State agency in administration of its federally aided public assistance programs. Such standards also shall place a limitation on the resources to be allowed eligible households. The standards of eligibility to be used by each State for the food stamp program shall be subject to the approval of the Secretary. (7 U.S.C. 2014.)

ISSUANCE AND USE OF COUPONS

SEC. 6. (a) Coupons shall be printed in such denominations as may be determined to be necessary, and shall be issued only to households which have been duly certified as eligible to participate in the food stamp program.

(b) Coupons issued to eligible households shall be used by them only to purchase food in retail food stores which have been approved for participation in the food stamp program at prices prevailing in such stores: *Provided*, That nothing in this Act shall be construed as authorizing the Secretary to specify the prices at which food may be sold by wholesale food concerns or retail food stores.

(c) Coupons issued to eligible households shall be simple in design and shall include only such words or illustrations as are required to explain their purpose and define their denomination. The name of any public official shall not appear on such coupons. (7 U.S.C. 2015.)

VALUE OF THE COUPON ALLOTMENT AND CHARGES TO BE MADE

SEC. 7. (a) The face value of the coupon allotment which State agencies shall be authorized to issue to households certified as eligible to participate in the food stamp program shall be in such amount as will provide such households with an opportunity more nearly to obtain a low-cost nutritionally adequate diet.

(b) Households shall be charged such portion of the face value of the coupon allotment issued to them as is determined to be equivalent to their normal expenditures for food.

(c) The value of the coupon allotment provided to any eligible household which is in excess of the amount charged such households for such allotment shall not be considered to be income or resources for any purpose under any Federal or State laws including, but not limited to, laws relating to taxation, welfare, and public assistance programs.

(d) Funds derived from the charges made for the coupon allotment shall be promptly deposited in a manner prescribed in the regulations issued pursuant to this Act, in a separate account maintained in the Treasury of the United States for such purpose. Such deposits shall be available, without limitation to fiscal years, for the redemption of coupons. (7 U.S.C. 2016.)

APPROVAL OF RETAIL FOOD STORES AND WHOLESALE FOOD CONCERNS

SEC. 8. (a) Regulations issued pursuant to this Act shall provide for the submission of applications for approval by retail food stores and wholesale food concerns which desire to be authorized to accept and redeem coupons under the food stamp program and for the approval of those applicants whose participation will effectuate the purposes of the food stamp program. In determining the qualifications of applicants there shall be considered among such other factors as may be appropriate, the following: (1) the nature and extent of the retail or wholesale food business conducted by the applicant; (2) the volume of coupon business which may reasonably be expected to be conducted by the applicant retail food store or wholesale food concern; and (3) the business integrity and reputation of the appli-

cant. Approval of an applicant shall be evidenced by the issuance to such applicant of a nontransferable certificate of approval.

(b) Regulations issued pursuant to this Act shall require an applicant retail food store or wholesale food concern to submit information which will permit a determination to be made as to whether such applicant qualifies, or continues to qualify, for approval under the provisions of this Act or the regulations issued pursuant to this Act. Regulations issued pursuant to this Act shall provide for safeguards which restrict the use or disclosure of information obtained under the authority granted by the subsection to purposes directly connected with administration and enforcement of the provisions of this Act or the regulations issued pursuant to this Act.

(c) Any retail food store or wholesale food concern which has failed upon application to receive approval to participate in the food stamp program may obtain a hearing on such refusal as provided in section 13 of this Act. (7 U.S.C. 2017.)

REDEMPTION OF COUPONS

SEC. 9. Regulations issued pursuant to this Act shall provide for the redemption of coupons accepted by retail food stores through approved wholesale food concerns or through banks, with the cooperation of the Treasury Department. (7 U.S.C. 2018.)

ADMINISTRATION

SEC. 10. (a) All practicable efforts shall be made in the administration of the food stamp program to insure that participants use their increased food purchasing power to obtain those staple foods most needed in their diets, and particularly to encourage the continued use of those in abundant or surplus supply so as not to reduce the total consumption of surplus commodities which have been made available through direct distribution. In addition to such steps as may be taken administratively, the voluntary cooperation of existing Federal, State, local, or private agencies which carry out informational and educational programs for consumers shall be enlisted.

(b) The State agency of each participating State shall assume responsibility for the certification of applicant households and for the issuance of coupons: *Provided*, That the State agency may, subject to State law, delegate its responsibility in connection with the issuance of coupons to another agency of the State government. There shall be kept such records as may be necessary to ascertain whether the program is being conducted in compliance with the provisions of this Act and the regulations issued pursuant to this Act. Such records shall be available for inspection and audit at any reasonable time and shall be preserved for such period of time, not in excess of three years, as may be specified in the regulations.

(c) In the certification of applicant households for the food stamp program there shall be no discrimination against any household by reason of race, religious creed, national origin, or political beliefs.

(d) Participating States or participating political subdivisions thereof shall not decrease welfare grants or other similar aid extended to any person or persons as a consequence of such person's or persons'

participation in benefits made available under the provisions of this Act or the regulations issued pursuant to this Act.

(e) The State agency of each State desiring to participate in the food stamp program shall submit for approval a plan of operation specifying the manner in which such program will be conducted within the State, the political subdivisions within the State in which the State desires to conduct the program, and the effective dates of participation by each such political subdivision. In addition, such plan of operation shall provide, among such other provisions as may by regulation be required, the following: (1) the specific standards to be used in determining the eligibility of applicant households; (2) that the State agency shall undertake the certification of applicant households in accordance with the general procedures and personnel standards used by them in the certification of applicants for benefits under the federally aided public assistance programs; (3) safeguards which restrict the use or disclosure of information obtained from applicant households to persons directly connected with the administration or enforcement of the provisions of this Act or the regulations issued pursuant to this Act; and (4) for the submission of such reports and other information as may from time to time be required. In approving the participation of the subdivisions requested by each State in its plan of operation, the Secretary shall provide for an equitable and orderly expansion among the several States in accordance with their relative need and readiness to meet their requested effective dates of participation.

(f) If the Secretary determines that in the administration of the program there is a failure by a State agency to comply substantially with the provisions of this Act, or with the regulations issued pursuant to this Act, or with the State plan of operation, he shall inform such State agency of such failure and shall allow the State agency a reasonable period of time for the correction of such failure. Upon the expiration of such period, the Secretary shall direct that there be no further issuance of coupons in the political subdivisions where such failure has occurred until such time as satisfactory corrective action has been taken.

(g) If the Secretary determines that there has been gross negligence or fraud on the part of the State agency in the certification of applicant households, the State shall upon request of the Secretary deposit into the separate account authorized by section 7 of this Act, a sum equal to the amount by which the value of any coupons issued as a result of such negligence or fraud exceeds the amount that was charged for such coupons under section 7(b) of this Act. (7 U.S.C. 2019.)

DISQUALIFICATION OF RETAIL FOOD STORES AND WHOLESALE FOOD CONCERNS

SEC. 11. Any approved retail food store or wholesale food concern may be disqualified from further participation in the food stamp program on a finding, made as specified in the regulations, that such store or concern has violated any of the provisions of this Act, or of the regulations issued pursuant to this Act. Such disqualification shall be for such period of time as may be determined in accordance

with regulations issued pursuant to this Act. The action of disqualification shall be subject to review as provided in section 13 of this Act. (7 U.S.C. 2020.)

DETERMINATION AND DISPOSITION OF CLAIMS

SEC. 12. The Secretary shall have the power to determine the amount of and settle and adjust any claim and to compromise or deny all or part of any such claim or claims arising under the provisions of this Act or the regulations issued pursuant to this Act. (7 U.S.C. 2021.)

ADMINISTRATIVE AND JUDICIAL REVIEW

SEC. 13. Whenever—

(a) an application of a retail food store or wholesale food concern to participate in the food stamp program is denied,

(b) a retail food store or a wholesale food concern is disqualified under the provisions of section 11 of this Act, or

(c) all or part of any claim of a retail food store or wholesale food concern is denied under the provisions of section 12 of this Act, notice of such administrative action shall be issued to the retail food store or wholesale food concern involved. Such notice shall be delivered by certified mail or personal service. If such store or concern is aggrieved by such action, it may, in accordance with regulations promulgated under this Act, within ten days of the date of delivery of such notice, file a written request for an opportunity to submit information in support of its position to such person or persons as the regulations may designate. If such a request is not made or if such store or concern fails to submit information in support of its position after filing a request, the administrative determination shall be final. If such a request is made by such store or concern, such information as may be submitted by the store or concern, as well as such other information as may be available, shall be reviewed by the person or persons designated, who shall, subject to the right of judicial review hereinafter provided, make a determination which shall be final and which shall take effect fifteen days after the date of the delivery or service of such final notice of determination. If the store or concern feels aggrieved by such final determination he may obtain judicial review thereof by filing a complaint against the United States in the United States district court for the district in which he resides or is engaged in business, or in any court of record of the State having competent jurisdiction, within thirty days after the date of delivery or service of the final notice of determination upon him, requesting the court to set aside such determination. The copy of the summons and complaint required to be delivered to the official or agency whose order is being attacked shall be sent to the Secretary or such person or persons as he may designate to receive service of process. The suit in the United States district court or State court shall be a trial de novo by the court in which the court shall determine the validity of the questioned administrative action in issue. If the court determines that such administrative action is invalid it shall enter such judgment or order as it determines is in accordance with the law and the

evidence. During the pendency of such judicial review, or any appeal therefrom, the administrative action under review shall be and remain in full force and effect, unless an application to the court on not less than ten days' notice, and after hearing thereon and a showing of irreparable injury, the court temporarily stays such administrative action pending disposition of such trial or appeal. (7 U.S.C. 2022.)

VIOLATIONS AND ENFORCEMENT

SEC. 14. (a) Notwithstanding any other provisions of this Act, the Secretary may provide for the issuance or presentment for redemption of coupons to such person or persons, and at such times and in such manner, as he deems necessary or appropriate to protect the interests of the United States or to insure enforcement of the provisions of this Act or the regulations issued pursuant to this Act.

(b) Whoever knowingly uses, transfers, acquires, or possesses coupons in any manner not authorized by this Act or the regulations issued pursuant to this Act shall, if such coupons are of the value of $100 or more, be guilty of a felony and shall, upon conviction thereof, be fined not more than $10,000 or imprisoned for not more than five years, or both, or, if such coupons are of a value of less than $100, shall be guilty of a misdemeanor and shall, upon conviction thereof, be fined not more than $5,000 or imprisoned for not more than one year, or both.

(c) Whoever presents, or causes to be presented, coupons for payment or redemption of the value of $100 or more, knowing the same to have been received, transferred, or used in any manner in violation of the provisions of this Act or the regulations issued pursuant to this Act shall be guilty of a felony and shall, upon conviction thereof, be fined not more than $10,000 or imprisoned for not more than five years, or both, or, if such coupons are of a value of less than $100, shall be guilty of a misdemeanor and shall, upon conviction thereof, be fined not more than $5,000 or imprisoned for not more than one year, or both.

(d) Coupons issued pursuant to this Act shall be deemed to be obligations of the United States within the meaning of title 18, United States Code, section 8. (7 U.S.C. 2023.)

COOPERATION WITH STATE AGENCIES

SEC. 15. (a) Each State shall be responsible for financing, from funds available to the State or political subdivision thereof, the costs of carrying out the administrative responsibilities assigned to it under the provisions of this Act. Except as provided for in subsection (b) of this section, such costs shall include, but shall not be limited to, the certification of households; the acceptance, storage, and protection of coupons after their delivery to receiving points within the States; and the issuance of such coupons to eligible households and the control and accounting therefor.

(b) The Secretary is authorized to cooperate with State agencies in the certification of households which are not receiving any type of public assistance so as to insure the effective certification of such households in accordance with the eligibility standards approved under the provisions of section 10 of this Act. Such cooperation shall include

payments to State agencies for part of the cost they incur in the certification of such households. The amount of such payment to any one State agency shall be 50 per centum of the sum of: (1) the direct salary costs (including the cost of such fringe benefits as are normally paid to its personnel by the State agency) of the personnel used to make such interviews and such postinterview field investigations as are necessary to certify the eligibility of such households, and of the immediate supervisor of such personnel, for such periods of time as they are employed in certifying the eligibility of such households; (2) travel and related costs incurred by such personnel in postinterview field investigations of such households; and (3) an amount not to exceed 25 per centum of the costs computed under (1) and (2) above. (7 U.S.C. 2024.)

APPROPRIATIONS

SEC. 16. (a) To carry out the provisions of this Act, there is hereby authorized to be appropriated not in excess of $75,000,000 for the fiscal year ending June 30, 1965; not in excess of $100,000,000 for the fiscal year ending June 30, 1966; and not in excess of $200,000,000 for the fiscal year ending June 30, 1967; and not in excess of such sum as may hereafter be authorized by Congress for any subsequent fiscal year. Such portion of any such appropriation as may be required to pay for the value of the coupon allotments issued to eligible households which is in excess of the charges paid by such households for such allotments shall be transferred to and made a part of the separate account created under section 7(d) of this Act.

(b) In any fiscal year, the Secretary shall limit the value of those coupons issued which is in excess of the value of coupons for which households are charged, to an amount which is not in excess of the portion of the appropriation for such fiscal year which is transferred to the separate account under the provisions of subsection (a) of this section. If in any fiscal year the Secretary finds that the requirements of participating States will exceed the limitation set forth herein, the Secretary shall direct State agencies to reduce the amount of such coupons to be issued to participating households to the extent necessary to comply with the provisions of this subsection.

(c) If the Secretary determines that any of the funds in the separate account created under section 7(d) of this Act are no longer required to carry out the provisions of this Act, such portion of such funds shall be paid into the miscellaneous receipts of the Treasury.

(d) Amounts expended under the authority of this Act shall not be considered amounts expended for the purpose of carrying out the agricultural price-support program and appropriations for the purposes of this Act shall be considered, for the purpose of budget presentations, to relate to the functions of the Government concerned with welfare. (7 U.S.C. 2025.)

DECLARATIONS OF POLICY

Agricultural Act of 1961—SEC. 2. In order more fully and effectively to improve, maintain, and protect the prices and incomes of farmers, to enlarge rural purchasing power, to achieve a better balance between supplies of agricultural commodities and the requirements of consumers therefor, to preserve and strengthen the structure of agriculture, and to revitalize and stabilize the overall economy at reasonable costs to the Government, it is hereby declared to be the policy of Congress to—

(a) afford farmers the opportunity to achieve parity of income with other economic groups by providing them with the means to develop and strengthen their bargaining power in the Nation's economy;

(b) encourage a commodity-by-commodity approach in the solution of farm problems and provide the means for meeting varied and changing conditions peculiar to each commodity;

(c) expand foreign trade in agricultural commodities with friendly nations, as defined in section 107 of Public Law 480, 83d Congress, as amended (7 U.S.C. 1707), and in no manner either subsidize the export, sell, or make available any subsidized agricultural commodity to any nations other than such friendly nations and thus make full use of our agricultural abundance;

(d) utilize more effectively our agricultural productive capacity to improve the diets of the Nation's needy persons;

(e) recognize the importance of the family farm as an efficient unit of production and as an economic base for towns and cities in rural areas and encourage, promote, and strengthen this form of farm enterprise;

(f) facilitate and improve credit services to farmers by revising, expanding, and clarifying the laws relating to agricultural credit;

(g) assure consumers of a continuous, adequate, and stable supply of food and fiber at fair and reasonable prices;

(h) reduce the cost of farm programs, by preventing the accumulation of surpluses; and

(i) use surplus farm commodities on hand as fully as practicable as an incentive to reduce production as may be necessary to bring supplies on hand and firm demand in balance. (75 Stat. 294, 7 U.S.C. 1282.)

Food and Agriculture Act of 1962—SEC. 402. Congress hereby reconfirms its long-standing policy of favoring the use by governmental agencies of the usual and customary channels, facilities, and arrangements of trade and commerce, and directs the Secretary of Agriculture and the Commodity Credit Corporation to the maximum extent practicable to adopt policies and procedures designed to minimize the acquisition of stocks by the Commodity Credit Corporation, to encourage orderly marketing of farm commodities through private competitive trade channels, both cooperative and noncooperative, and to obtain maximum returns in the marketplace for producers and for the Commodity Credit Corporation. (76 Stat. 632, 15 U.S.C. 713–13.)

Agricultural Act of 1954—SEC. 204. (a) The production and use of abundant supplies of high quality milk and dairy products are

essential to the health and general welfare of the Nation; a dependable domestic source of supply of these foods in the form of high grade dairy herds and modern sanitary dairy equipment is important to the national defense; and an economically sound dairy industry affects beneficially the economy of the country as a whole. It is the policy of Congress to assure a stabilized annual production of adequate supplies of milk and dairy products; to promote the increased use of these essential foods; to improve the domestic source of supply of milk and butterfat by encouraging dairy farmers to develop efficient production units consisting of high-grade, disease-free cattle and modern sanitary equipment; and to stabilize the economy of dairy farmers at a level which will provide a fair return for their labor and investment when compared with the cost of things that farmers buy. (7 U.S.C. 1446b.)

CONSULTATION ON AGRICULTURAL PROGRAMS

Agricultural Act of 1961—SEC. 102. (a) Notwithstanding any other provision of law, whenever the Secretary of Agriculture determines that additional legislative authority is necessary to develop new agricultural programs involving supply adjustments or marketing regulations through marketing orders, marketing quotas, or price support programs with respect to any agricultural commodity, or to make substantial revisions in any existing agricultural legislation or programs, he may consult and advise with farmers, farm organizations, and appropriate commodity organizations, if any, for the commodity involved, to review the problems involved, the need for new legislation, and the provisions which should be included in any such proposed legislation.

(b) In addition, whenever and to the extent he deems such action necessary or desirable, the Secretary of Agriculture may consult and advise with any person or group of persons, or organizations, including farmers, handlers, processors, or others connected with the production, processing, handling, or use of the commodity involved, with respect to the problems involved and need for legislation and the provisions which should be included in any such proposed legislation.

(c) In order that the Secretary of Agriculture may be assured of being able to obtain the advice of any such person or organization, he is authorized, whenever he determines such action necessary, to pay for each day's attendance at meetings and while traveling to and from such meetings, transportation expenses and in lieu of subsistence, a per diem in the amount authorized under the Travel Expense Act of 1949 for Federal employees. No salary or other compensation shall be paid. (7 U.S.C. 1911.)

SEC. 103. If the Secretary of Agriculture, after such consultation and receipt of such advice as provided in section 102 of this Act, determines that additional legislative authority is necessary to develop agricultural programs involving supply adjustments or marketing regulations through the use of marketing orders, marketing quotas or price-support programs, he shall formulate specific recommendations in the

form of proposed legislation which shall be submitted to the Congress together with a statement setting forth the purpose and need for such proposed legislation. (7 U.S.C. 1912.)

SEC. 104. Nothing in this Act shall be deemed to limit the authority of the Secretary of Agriculture under other provision of law or to establish or consult with advisory committees. (7 U.S.C. 1913.)

AGRICULTURAL ATTACHÉS

Agricultural Act of 1954—SEC. 601. For the purpose of encouraging and promoting the marketing of agricultural products of the United States and assisting American farmers, processors, distributors, and exporters to adjust their operations and practices to meet world conditions, the Secretary of Agriculture shall acquire information regarding the competition and demand for United States agricultural products, the marketing and distribution of said products in foreign countries and shall be responsible for the interpretation and dissemination of such information in the United States and shall make investigations abroad regarding the factors affecting and influencing the export of United States agricultural products, and shall conduct abroad any other activities including the demonstration of standards of quality for American agricultural products for which the Department of Agriculture now has or in the future may have such standards, as he deems necessary. Nothing contained herein shall be construed as prohibiting the Department of Agriculture from conducting abroad any activity for which authority now exists. (7 U.S.C. 1761.)

ESTABLISHMENT OF FEDERAL AGRICULTURAL SERVICES TO GUAM

PUBLIC LAW 88–584 SEPTEMBER 7, 1964

AN ACT

To establish Federal agricultural services to Guam, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of Agriculture is authorized to establish and maintain an agricultural program in Guam which will include such programs administered by the United States Department of Agriculture, hereinafter referred to as "Department", as are determined by the Secretary will promote the welfare of that island. This authority may be exercised without regard to section 25(b) of the Organic Act of Guam (64 Stat. 390; 48 U.S.C. 1421c(b)), or any other provision of law under which Guam may have been excluded from such programs. The Secretary is authorized to provide for such modification of any such programs extended to Guam as he deems necessary in order to adapt it to the needs of Guam. The program authorized by this section shall be developed in cooperation with the territorial government of Guam and shall be covered by a memoradum of understanding agreed to by the territorial government and the Department. The Secretary may also utilize the agencies, facilities, and employees of the Department, and may cooperate with other public agencies and with private organizations and individuals in Guam and elsewhere: *Provided*, That

the number of employees of the United States Department of Agriculture stationed on Guam to carry out the purposes of this Act shall not exceed three at any one time.

SEC. 2. There are hereby authorized to be appropriated such sums, but not to exceed $60,000 per annum, as may be necessary to carry out the purposes of this Act. Sums appropriated in pursuance of this Act shall be in addition to, and not in substitution for, sums appropriated or otherwise made available to the Department, and may be allocated to such agencies of the Department as are concerned with the administration of the program in Guam.

SEC. 3. All provisions of this Act shall terminate five years from the date of enactment of this Act. (78 Stat. 926.)

COMPROMISING, ADJUSTING, OR CANCELING DEBTS

ACT OF DECEMBER 20, 1944

The Secretary of Agriculture, hereinafter referred to as the Secretary, is hereby authorized and directed to compromise, adjust, or cancel indebtedness arising from loans and payments made or credit extended to farmers under the provisions of the several Acts of Congress or programs enumerated in section 2: *Provided*, That the Secretary finds, after such investigation as he deems sufficient to establish the facts, that (1) said indebtedness has been due and payable for five years or more; (2) the debtor is unable to pay said indebtedness in full and has no reasonable prospect of being able to do so; (3) the debtor has acted in good faith in an effort to meet his obligation; and (4) the principal amount of said indebtedness is not in excess of $1,000. The Secretary is hereby further authorized at his discretion to cancel and discharge indebtedness arising under said Acts of Congress or programs when the amount of said indebtedness is less than $10, or the debtor is deceased and there is no reasonable prospect of recovering from his estate, or his whereabouts has remained unknown for two years and there is no reasonable prospect of obtaining collection, or he has been discharged of the indebtedness in any proceeding under the Act entitled "An Act to establish a uniform system of bankruptcy throughout the United States." The compromises, adjustments, or cancelations authorized by this section shall be effected through such agencies, upon such terms and conditions, and subject to such regulations, as the Secretary may prescribe, and the Secretary may delegate the exercise of any such powers and functions to such officers or employees of the Department of Agriculture as he may designate. (12 U.S.C. 1150.)

SEC. 2. The provisions of this Act shall apply to any indebtedness of farmers arising from loans or payments made or credit extended to them under any of the following Acts or programs: (a) July 1, 1918 (40 Stat. 635); March 3, 1921 (41 Stat. 1347); March 20, 1922 (42 Stat. 467); April 26, 1924 (43 Stat. 110); February 25, 1927 (44 Stat. 1245); February 28, 1927 (44 Stat., part II, 1251); February 25, 1929 (45 Stat. 1306), as amended May 17, 1929 (46 Stat. 3); March 3, 1930 (46 Stat. 78–79), as amended April 24, 1930 (46 Stat. 254); December 20, 1930 (46 Stat. 1032), as amended February 14, 1931 (46 Stat. 1160); February 23, 1931 (46 Stat. 1276); January

22, 1932 (47 Stat. 5); March 3, 1932 (47 Stat. 60); February 4, 1933 (47 Stat. 795); February 23, 1934 (48 Stat. 354); June 19, 1934 (48 Stat. 1056); February 20, 1935 (49 Stat. 28); March 21, 1935 (49 Stat. 50); April 8, 1935 (49 Stat. 115); (Executive Order No. 7305); January 29, 1937 (50 Stat. 5); and February 4, 1938 (52 Stat. 27); (b) Agricultural Adjustment Act (of 1933); Bankhead Cotton Act of April 21, 1934, on account of the several cotton tax-exemption certificate pools; Jones-Connally Cattle Act of April 7, 1934; Emergency Appropriation Act, fiscal year 1935, approved June 19, 1934; Kerr Tobacco Act of June 28, 1934, and Public Resolution Numbered 76, approved March 14, 1936; section 32 of the Act of August 24, 1935, and related legislation; Supplemental Appropriation Act, fiscal year 1936; sections 7 to 17 of the Soil Conservation and Domestic Allotment Act; Sugar Act of 1937; sections 303 and 381(a) of the Agricultural Adjustment Act of 1938 and related or subsequent legislation authorizing parity or price adjustment payments; title IV and title V of the Agricultural Adjustment Act of 1938 and related legislation; any amendment to any of the foregoing Acts heretofore and any other Act of Congress heretofore enacted authorizing payments to farmers under programs administered through the Agricultural Adjustment Agency; (c) Loans made by or through the Resettlement Administration or the Farm Security Administration out of funds appropriated or made available by or pursuant to the following Acts: April 8, 1935 (49 Stat. 115); June 22, 1936 (49 Stat. 1608); February 9, 1937 (50 Stat. 8); June 29, 1937 (50 Stat. 352); The Bankhead-Jones Farm Tenant Act, July 22, 1937 (50 Stat. 522 et seq.); the Water Facilities Act of August 28, 1937 (50 Stat. 869 et seq.); March 2, 1938 (52 Stat. 83, Public Resolution Numbered 80); June 21, 1938 (52 Stat. 809); June 30, 1939 (53 Stat. 927); June 26, 1940 (Public Resolution Numbered 88); flood-restoration loans, Second Deficiency Appropriation Act, 1943 (57 Stat. 537, 542); and subsequent legislation appropriating or making available funds for such loans; commodity loan, purchase, sale, and other programs of the Commodity Credit Corporation; and crop-insurance programs formulated pursuant to title V of the Agricultural Adjustment Act of 1938 (the Federal Crop Insurance Act), and any amendment or supplement thereto heretofore or hereafter enacted. This Act shall also apply to any indebtedness of farmers evidenced by notes or accounts receivable, title to which has been acquired in the liquidation of loans to cooperative associations made under the provisions of the Act of June 15, 1929 (46 Stat. 11). (12 U.S.C. 1150a.)

SEC. 3. There is hereby authorized to be appropriated, out of any money in the Treasury not otherwise appropriated, such amount as may be necessary to enable the Secretary to carry out the provisions of this Act, and the current and subsequent appropriations to enable the Secretary to administer the respective Acts of Congress or programs to which the aforesaid payments or loans or extensions of credit relate shall also be available for the administrative expenses of carrying out this Act. (12 U.S.C. 1150b.)

SEC. 4. [Repealed, effective September 1, 1948, by 62 Stat. 862. Provisions of this section are now covered by sections 217 and 1026 of Title 18, U.S.C.]

CARGO PREFERENCE ACT

Public Law 664—83d Congress

Act of August 26, 1954

AN ACT

To amend the Merchant Marine Act, 1936, to provide permament legislation for the transportation of a substantial portion of waterborne cargoes in United States-flag vessels.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 901 of the Merchant Marine Act, 1936, as amended, is hereby amended by inserting "(a)" after "SEC. 901." and by adding at the end of the section the following new subsection:

"(b) whenever the United States shall procure, contract for, or otherwise obtain for its own account, or shall furnish to or for the account of any foreign nation without provision for reimbursement, any equipment, materials, or commodities, within or without the United States, or shall advance funds or credits or guarantee the convertibility of foreign currencies in connection with the furnishing of such equipment, materials, or commodities, the appropriate agency or agencies shall take such steps as may be necessary and practicable to assure that at least 50 per centum of the gross tonnage of such equipment, materials, or commodities (computed separately for dry bulk carriers, dry cargo liners, and tankers), which may be transported on ocean vessels shall be transported on privately owned United States-flag commercial vessels, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels, in such manner as will insure a fair and reasonable participation of United States-flag commercial vessels in such cargoes by geographic areas: *Provided*, That the provisions of this subsection may be waived whenever the Congress by concurrent resolution or otherwise, or the President of the United States or the Secretary of Defense declares that an emergency exists justifying a temporary waiver of the provisions of section 901(b) and so notifies the appropriate agency or agencies: *And provided further*, That the provisions of this subsection shall not apply to cargoes carried in the vessels of the Panama Canal Company. Nothing herein shall repeal or otherwise modify the provisions of Public Resolution Numbered 17, Seventy-third Congress (48 Stat. 500), as amended." [1] (68 Stat. 832, 46 U.S.C. 1241(b).)

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[1] Sec. 3 of the Act of August 3, 1956, 70 Stat. 988, provides that the sales of fresh fruit and the products thereof under Title I of the Agricultural Trade Development and Assistance Act of 1954 shall be exempt from the requirements of the cargo preference laws. (7 U.S.C. 1701 note, 15 U.S.C. 616a note, 46 U.S.C. 1241 note.)

HUMANE METHODS OF SLAUGHTER ACT

Act of August 27, 1958—Sec. 3. The public policy declared herein shall be taken into consideration by all agencies of the Federal Government in connection with all procurement and price support programs and operations and after June 30, 1960, no agency or instrumentality of the United States shall contract for or procure any livestock products produced or processed by any slaughterer or processor which in any of its plants or in any plants of any slaughterer or processor with which it is affiliated slaughters or handles in connection with slaughter livestock by any methods other than methods designated and approved by the Secretary of Agriculture (hereinafter referred to as the Secretary) pursuant to section 4 hereof: *Provided*, That during the period of any national emergency declared by the President or the Congress, the limitations on procurement required by this section may be modified by the President to the extent determined by him to be necessary to meet essential procurement needs during such emergency. For the purposes of this section a slaughterer or processor shall be deemed to be affiliated with another slaughterer or processor if it controls, is controlled by, or is under common control with, such other slaughterer or processor. After June 30, 1960, each supplier from which any livestock products are procured by any agency of the Federal Government shall be required by such agency to make such statement of eligibility under this section to supply such livestock products as, if false, will subject the maker thereof to prosecution, title 18, United States Code, section 287. (72 Stat. 862, approved August 27, 1958, 7 U.S.C. 1903.)

758-820—65——23

PART VIII

DEPARTMENT OF AGRICULTURE AND RELATED AGENCIES APPROPRIATION ACT, 1965[1]

AN ACT

Making appropriations for the Department of Agriculture and related agencies for the fiscal year ending June 30, 1965, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums are appropriated, out of any money in the Treasury not otherwise appropriated, for the Department of Agriculture and related agencies for the fiscal year ending June 30, 1965, and for other purposes; namely:

DEPARTMENT OF AGRICULTURE

TITLE I—GENERAL ACTIVITIES

Agriculture Research Service

SALARIES AND EXPENSES

* * * * * * *

Plant and animal disease and pest control: For operations and measures, not otherwise provided for, to control and eradicate pests and plant and animal diseases and for carrying out assigned inspection, quarantine, and regulatory activities, as authorized by law, including expenses pursuant to the Act of February 28, 1947, as amended (21 U.S.C. 114b–c), $68,793,200, of which $1,500,000 shall be apportioned for use pursuant to section 3679 of the Revised Statutes, as amended, for the control of outbreaks of insects and plant diseases to the extent necessary to meet emergency conditions: *Provided*, That no funds shall be used to formulate or administer a brucellosis eradication program for the current fiscal year that does not require minimum matching by any State of at least 40 per centum: *Provided further*, That no funds in excess of $250,000 shall be available for carrying out the screwworm eradication program that does not require minimum matching by State or local sources of at least 50 per centum of the expenses of production, irradiation, and release of the screwworm flies: *Provided further*, That, in addition, in emergencies which threaten the livestock or poultry industries of the country, the Secretary may transfer from other appropriations or funds available to the agencies or corporations of the Department such sums as he may deem necessary, to be available only in such emergencies for the arrest and eradication of foot-and-mouth disease, rinderpest, contagious

[1] Pub. L. 88–573, 78 Stat. 862, approved September 2, 1964.

pleuropneumonia, or other contagious or infectious diseases of animals, or European fowl pest and similar diseases in poultry, and for expenses in accordance with the Act of February 28, 1947, as amended, and any unexpended balances of funds transferred under this head in the next preceding fiscal year shall be merged with such transferred amounts;

SALARIES AND EXPENSES (SPECIAL FOREIGN CURRENCY PROGRAM)

For payments in foreign currencies which accrue under title I of the Agricultural Trade Development and Assistance Act of 1954, as amended (7 U.S.C. 1704), for market development research authorized by section 104(a) and for agricultural and forestry research and other functions related thereto authorized by section 104(k) of the Agricultural Trade Development and Assistance Act of 1954, as amended (7 U.S.C. 1704(a)(k)), to remain available until expended, $2,000,000: *Provided*, That this appropriation shall be available in addition to other appropriations for these purposes, for payments in the foregoing currencies: *Provided further*, That funds appropriated herein shall be used for payments in such foreign currencies as the Department determines are needed and can be used most effectively to carry out the purposes of this paragraph, and such foreign currencies shall, pursuant to the provisions of section 104(a), be set aside for sale to the Department before foreign currencies which accrue under said title I are made available for other United States uses: *Provided further*, That not to exceed $25,000 of this appropriation shall be available for payments in foreign currencies for expenses of employment pursuant to the second sentence of section 706(a) of the Organic Act of 1944 (5 U.S.C. 574), as amended by section 15 of the Act of August 2, 1946 (5 U.S.C. 55a).

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SOIL CONSERVATION SERVICE

* * * * * * *

GREAT PLAINS CONSERVATION PROGRAM

For necessary expenses to carry into effect a program of conservation in the Great Plains area, pursuant to section 16(b) of the Soil Conservation and Domestic Allotment Act, as added by the Act of August 7, 1956 (16 U.S.C. 590p), $14,744,000, to remain available until expended.

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AGRICULTURAL MARKETING SERVICE

* * * * * * *

SPECIAL MILK PROGRAM

For necessary expenses to carry out the Special Milk Program, as authorized by the Act of August 8, 1961 (7 U.S.C. 1446, note), $103,000,000, of which $51,500,000 shall be derived by transfer from funds available under section 32 of the Act of August 24, 1935 (7 U.S.C. 612): *Provided*, That hereafter appropriations under this head shall be made in accordance with the provisions of Public Law 87–128.

SCHOOL LUNCH PROGRAM

For necessary expenses to carry out the provisions of the National School Lunch Act, as amended (42 U.S.C. 1751–1760), $146,400,000: *Provided*, That no part of this appropriation shall be used for non-food assistance under section 5 of said Act: *Provided further*, That $45,000,000 shall be transferred to this appropriation from funds available under section 32 of the Act of August 24, 1935, for purchase and distribution of agricultural commodities and other foods pursuant to section 6 of the National School Lunch Act.

REMOVAL OF SURPLUS AGRICULTURAL COMMODITIES

(SECTION 32)

No funds available under section 32 of the Act of August 24, 1935 (7 U.S.C. 612c) shall be used for any purpose other than commodity program expenses as authorized therein, and other related operating expenses, except for (1) transfers to the Department of the Interior as authorized by the Fish and Wildlife Act of August 8, 1956, (2) transfers otherwise provided in this Act, (3) not more than $2,924,000 for formulation and administration of marketing agreements and orders pursuant to the Agricultural Marketing Agreement Act of 1937, as amended, and the Agricultural Act of 1961, (4) not more than $35,000,000 for expenses for the Pilot Food Stamp Program and (5) not in excess of $12,175,000 to be used to increase domestic consumption of farm commodities pursuant to authority contained in Public Law 88–250, the Department of Agriculture and Related Agencies Appropriation Act, 1964, of which amount $500,000 shall remain available until expended for construction, alteration and modification of research facilities.

FOREIGN AGRICULTURAL SERVICE

SALARIES AND EXPENSES

For necessary expenses for the Foreign Agricultural Service, including carrying out title VI of the Agricultural Act of 1954 (7 U.S.C. 1761–1768), market development activities abroad, and for enabling the Secretary to coordinate and integrate activities of the Department in connection with foreign agricultural work, including not to exceed $35,000 for representation allowances and for expenses pursuant to section 8 of the Act approved August 3, 1956 (7 U.S.C. 1766), $20,488,000: *Provided*, That not less than $255,000 of the funds contained in this appropriation shall be available to obtain statistics and related facts on foreign production and full and complete information on methods used by other countries to move farm commodities in world trade on a competitive basis: *Provided further*, That, in addition, not to exceed $3,117,000 of the funds appropriated by section 32 of the Act of August 24, 1935, as amended (7 U.S.C. 612c), shall be merged with this appropriation and shall be available for all expenses of the Foreign Agricultural Service.

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Agricultural Stabilization and Conservation Service

EXPENSES, AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE

For necessary administrative expenses of the Agricultural Stabilization and Conservation Service, including expenses to formulate and carry out programs authorized by title III of the Agricultural Adjustment Act of 1938, as amended (7 U.S.C. 1301–1393); Sugar Act of 1948, as amended (7 U.S.C. 1101–1161); sections 7 to 15, 16(a), 16(d), 16(e), 16(f), and 17 of the Soil Conservation and Domestic Allotment Act, as amended (16 U.S.C. 590g–590q; 7 U.S.C. 1010–1011) as added by section 132 of the Act of August 8, 1961; subtitles B and C of the Soil Bank Act (7 U.S.C. 1831–1837, 1802–1814, and 1816); and laws pertaining to the Commodity Credit Corporation, $105,602,000: *Provided*, That, in addition, not to exceed $87,508,000 may be transferred to and merged with this appropriation from the Commodity Credit Corporation fund (including not to exceed $35,668,000 under the limitation on Commodity Credit Corporation administrative expenses): *Provided further*, That other funds made available to Agricultural Stabilization and Conservation Service for authorized activities may be advanced to and merged with this appropriation: *Provided further*, That no part of the funds appropriated or made available under this Act shall be used, (1) to influence the vote in any referendum; (2) to influence agricultural legislation, except as permitted in 18 U.S.C. 1913; or (3) for salaries or other expenses of members of county and community committees established pursuant to section 8(b) of the Soil Conservation and Domestic Allotment Act, as amended, for engaging in any activities other than advisory and supervisory duties and delegated program function prescribed in administrative regulations.

SUGAR ACT PROGRAM

For necessary expenses to carry into effect the provisions of the Sugar Act of 1948 (7 U.S.C. 1101–1161), $90,000,000, to remain available until June 30 of the next succeeding fiscal year.

AGRICULTURAL CONSERVATION PROGRAM

For necessary expenses to carry into effect the program authorized in sections 7 to 15, 16(a), and 17 of the Soil Conservation and Domestic Allotment Act, approved February 29, 1936, as amended (16 U.S.C. 590g–590(o), 590p(a), and 590q), including not to exceed $6,000 for the preparation and display of exhibits, including such displays at State, interstate, and international fairs within the United States, $225,000,000, to remain available until December 31 of the next succeeding fiscal year for compliance with the programs of soil-building and soil- and water-conserving practices authorized under this head in the Department of Agriculture and Related Agencies Appropriation Acts, 1963 and 1964, carried out during the period July 1, 1962, to December 31, 1964, inclusive: *Provided*, That none of the funds herein appropriated shall be used to pay the salaries or expenses of any regional information employees or any State information employees, but this shall not preclude the answering of inquiries or supplying of information at the county level to individual farmers: *Provided further*, That

no portion of the funds for the current year's program may be utilized to provide financial or technical assistance for drainage on wetlands now designated as Wetland Types 3 (III), 4 (IV), and 5 (V) in United States Department of the Interior, Fish and Wildlife Service Circular 39, Wetlands of the United States, 1956: *Provided further*, That necessary amounts shall be available for administrative expenses in connection with the formulation and administration of the 1965 program of soil-building and soil- and water-conserving practices, including related wildlife conserving practices, under the Act of February 29, 1936, as amended (amounting to $220,000,000 excluding administration, except that no participant shall receive more than $2,500, except where the participants from two or more farms or ranches join to cary out approved practices designed to conserve or improve the agricultural resources of the community): *Provided further*, That not to exceed 5 per centum of the allocation for the current year's agricultural conservation program for any county may, on the recommendation of such county committee and approval of the State committee, be withheld and allotted to the Soil Conservation Service for services of its technicians in formulating and carrying out the agricultural conservation program in the participating counties, and shall not be utilized by the Soil Conservation Service for any purpose other than technical and other assistance in such counties, and in addition, on the recommendation of such county committee and approval of the State committee, not to exceed 1 per centum may be made available to any other Federal, State, or local public agency for the same purpose and under the same conditions: *Provided further*, That for the current year's program $2,500,000 shall be available for technical assistance in formulating and carrying out agricultural conservation practices: *Provided further*, That such amounts shall be available for the purchase of seeds, fertilizers, lime, trees, or any other farming material, or any soil-terracing services, and making grants thereof to agricultural producers to aid them in carrying out farming practices approved by the Secretary under programs provided for herein: *Provided further*, That no part of any funds available to the Department, or any bureau, office, corporation, or other agency constituting a part of such Department, shall be used in the current fiscal year for the payment of salary or travel expenses of any person who has been convicted of violating the Act entitled "An Act to prevent pernicious political activities", approved August 2, 1939, as amended, or who has been found in accordance with the provisions of title 18, United States Code, section 1913, to have violated or attempted to violate such section which prohibits the use of Federal appropriations for the payment of personal services or other expenses designed to influence in any manner a Member of Congress to favor or oppose any legislation or appropriation by Congress except upon request of any Member or through the proper official channels.

CONSERVATION RESERVE PROGRAM

For necessary expenses to carry out a conservation reserve program as authorized by subtitles B and C of the Soil Bank Act (7 U.S.C. 1831–1837, 1802–1814, and 1816), and to carry out liquidation activities for the acreage reserve program, to remain available until expended,

$194,000,000, with which may be merged the unexpended balances of funds heretofore appropriated for soil bank programs: *Provided*, That no part of these funds shall be paid on any contract which is illegal under the law due to the division of lands for the purpose of evading limits on annual payments to participants.

CROPLAND CONVERSION PROGRAM

For necessary expenses to promote the conservation and economic use of land pursuant to the provisions of section 16(e) of the Soil Conservation and Domestic Allotment Act (16 U.S.C. 590h, 590p), as amended, $15,000,000, to remain available until expended.

EMERGENCY CONSERVATION MEASURES

For emergency conservation measures, to be used for the same purposes and subject to the same conditions as funds appropriated under this head in the Third Supplemental Appropriation Act, 1957, to remain available until expended, $4,000,000, with which shall be merged the unexpended balances of funds heretofore appropriated for emergency conservation measures.

* * * * * * *

TITLE III—CORPORATIONS

The following corporations and agencies are hereby authorized to make such expenditures, within the limits of funds and borrowing authority available to each such corporation or agency and in accord with law, and to make such contracts and commitments without regard to fiscal year limitations as provided by section 104 of the Government Corporation Control Act, as amended, as may be necessary in carrying out the programs set forth in the budget for the current fiscal year for such corporation or agency, except as hereinafter provided:

Federal Crop Insurance Corporation

ADMINISTRATIVE AND OPERATING EXPENSES

For administrative and operating expenses, $6,942,000.

FEDERAL CROP INSURANCE CORPORATION FUND

Not to exceed $3,638,000 of administrative and operating expenses may be paid from premium income.

Commodity Credit Corporation

REIMBURSEMENT FOR NET REALIZED LOSSES

To partially reimburse the Commodity Credit Corporation for net realized losses sustained during the fiscal year ending June 30, 1963, pursuant to the Act of August 17, 1961 (15 U.S.C. 713a–11, 713a–12), $1,574,000,000.

LIMITATION ON ADMINISTRATIVE EXPENSES

Nothing in this Act shall be so construed as to prevent the Commodity Credit Corporation from carrying out any activity or any program authorized by law: *Provided*, That not to exceed $37,351,000 shall be available for administrative expenses of the Corporation: *Provided further*, That $945,000 of this authorization shall be available only to expand and strengthen the sales program of the Corporation pursuant to authority contained in the Corporation's charter: *Provided further*, That not less than 7 per centum of this authorization shall be placed in reserve to be apportioned pursuant to section 3679 of the Revised Statutes, as amended, for use only in such amounts and at such times as may become necessary to carry out program operations: *Provided further*, That all necessary expenses (including legal and special services performed on a contract or fee basis, but not including other personal services) in connection with the acquisition, operation, maintenance, improvement, or disposition of any real or personal property belonging to the Corporation or in which it has an interest, including expenses of collections of pledged collateral, shall be considered as nonadministrative expenses for the purposes hereof: *Provided further*, That no part of the administrative funds authorized under this head or of the capital funds of the Commodity Credit Corporation shall be available to formulate or administer a cotton loan program during fiscal year 1965 which requires that micronaire readings shall be mandatory as a part of the cotton classing in connection with cotton loans.

PUBLIC LAW 480

For expenses during fiscal year 1965, not otherwise recoverable, and unrecovered prior years' costs, including interest thereon, under the Agricultural Trade Development and Assistance Act of 1954, as amended (7 U.S.C. 1701–1709, 1721–1724, 1731–1736), to remain available until expended, as follows: (1) Sale of surplus agricultural commodities for foreign currencies pursuant to title I of said Act, $1,612,000,000; (2) commodities disposed of for emergency famine relief to friendly peoples pursuant to title II of said Act, $220,453,000; and (3) long-term supply contracts pursuant to title IV of said Act, $35,000,000.

INTERNATIONAL WHEAT AGREEMENT

For expenses during fiscal year 1965 and unrecovered prior years' costs, including interest thereon, under the International Wheat Agreement Act of 1949, as amended (7 U.S.C. 1641–1642), $31,838,000, to remain available until expended.

BARTERED MATERIALS FOR SUPPLEMENTAL STOCKPILE

For expenses during fiscal year 1965 and unrecovered prior years' costs related to strategic and other materials acquired as a result of barter or exchange of agricultural commodities or products and transferred to the supplemental stockpile pursuant to Public Law 540, Eighty-fourth Congress (7 U.S.C. 1856), $92,860,000, to remain available until expended.

* * * * * * *

TITLE V—GENERAL PROVISIONS

SEC. 501. Within the unit limit of cost fixed by law, appropriations and authorizations made for the Department under this Act shall be available for the purchase, in addition to those specifically provided for, of not to exceed four hundred and seventy-four passenger motor vehicles, of which four hundred and fifty-two shall be for replacement only, and for the hire of such vehicles.

SEC. 502. Provisions of law prohibiting or restricting the employment of aliens shall not apply to employment under the appropriation for the Foreign Agricultural Service.

SEC. 503. Funds available to the Department of Agriculture shall be available for uniforms or allowances therefor as authorized by the Act of September 1, 1954, as amended (5 U.S.C. 2131).

SEC. 504. No part of the funds appropriated by this Act shall be used for the payment of any officer or employee of the Department who, as such officer or employee, or on behalf of the Department or any division, commission, or bureau thereof, issues, or causes to be issued, any prediction, oral or written, or forecast, except as to damage threatened or caused by insects and pests, with respect to future prices of cotton or the trend of same.

SEC. 505. Except to provide materials required in or incident to research or experimental work where no suitable domestic product is available, no part of the funds appropriated by this Act shall be expended in the purchase of twine manufactured from commodities or materials produced outside of the United States.

SEC. 506. Not less than $1,500,000 of the appropriations of the Department for research and service work authorized by the Acts of August 14, 1946, July 28, 1954, and September 6, 1958 (7 U.S.C. 427, 1621–1629; 42 U.S.C. 1891–1893), shall be available for contracting in accordance with said Acts.

This Act may be cited as the "Department of Agriculture and Related Agencies Appropriation Act, 1965".

INDEX

Page

Acreage allotments. *See* Corn, Cotton, Peanuts, Rice, Tobacco, Wheat.
Acreage Reserve Program. *See* Soil Bank Act.
Acreage diversion 19
Act of April 11, 1964 55
Actual production. *See* Production.
Adjustment of marketing quotas 84, 97
Administrative areas 5, 75, 83, 95
Administrative expenditures:
  Agricultural Adjustment Act of 1938 ..... 113, 114
  Commodity Credit Corporation Charter Act 141
  Compromising, adjusting or canceling debts 332
  Federal Crop Insurance Act 249
  General 342
  International Wheat Agreement Act of 1949 ..... 190, 191
  Section 32 212
  Soil Bank Act 128
  Soil Conservation and Domestic Allotment Act 113, 114
  Sugar Act of 1948 273
Administrative expenses, deduction of, from payments 12, 112, 115
Administrative Procedure Act, functions excluded from 192
Advances:
  Administrative expenses of committees 114
  Agricultural conservation program 4, 113
  Commodity Credit Corporation 113
  Crop insurance premiums 13, 113, 236
Advances to departmental agencies:
  Brucellosis eradication 335
  Classing and grading 236
  Diseases of animals and poultry 336
  Foot and mouth disease 335
Advertising and sales promotion programs, wool, mohair, sheep, and goats 172
Advisory committee:
  Crop Insurance 248
  Pub. L. 480 202
Aerial photographs, availability of 112
Agreements, for changes in cropping systems and land uses 17
Agricultural Act of 1949, *see also* Price support 147–168
Agricultural Act of 1954 169–173
Agricultural Act of 1956:
  Title I—Soil Bank Act 117–131
  Title II—Surplus Disposal 183–187
Agricultural Adjustment Act (of 1933). *See* Agricultural Marketing Agreement Act of 1937 289–310
Agricultural Adjustment Act of 1938 27–115
Agricultural attaches 329
Agricultural commodities, products and byproducts:
  Base period for prices 29
  Expenditure to encourage exportation 184, 193, 211
  Promotion of sale by Secretary of Commerce 29
  Research into uses and markets 28
  Stimulation of use 29
  Transportation charges, parties to complaints 27–28
Agricultural commodity, defined 12, 249
  Basic 163
  Nonbasic 163

Page
Agricultural conservation program 1–23
Agricultural experiment stations, production exempt from penalty 98
Agricultural Extension Service. *See* Extension Service.
Agricultural Marketing Agreement Act of 1937. *See* Marketing Agreements and orders.
Agricultural programs, consultation on 328
Agricultural Surplus Disposal Administrator 187
Agricultural Trade Development and Assistance Act of 1954 193–209
Allocation of funds to:
  Animals, humane slaughter of 333
  Bureaus and offices of the Department for—
    Federal crop insurance 340
    Soil bank 338
    Soil conservation 338
    Sugar 338
  Commodities 14
  Research laboratories 28
  Secretary of Commerce 29
Allotment pool 102
Animals, humane slaughter 333
Appointment of officers and employees:
  Agricultural Adjustment Act of 1938 112
  Commodity Credit Corporation 140
  Federal Crop Insurance Corporation 244
  Soil Conservation and Domestic Allotment Act 2
Appropriation Act, fiscal year 1965:
  Agricultural conservation program 338
  Bartered materials for supplemental stockpile 341
  Commodity Credit Corporation 340
  Conservation reserve program 339
  Federal Crop Insurance Corporation 340
  General provisions—
    Aliens, employment of 342
    Automobiles 342
    Cotton, prohibition against price predictions 342
    Funds for contracts relating to research 342
    Twine, prohibition against purchase of 342
  Great Plains conservation program 336
  International wheat agreement 341
  Public Law 480 341
  School lunch program 337
  Special milk program 336
  Sugar Act 338
Appropriation authorizations:
  Cost of classing or grading 236
  Grain for waterfowl 220
  International Wheat Agreement 191
  Public Law 480 dispositions 196
  Sales for foreign currency 194–204
  Sec. 32 211
  Transfers to supplemental stockpile 179
Assignment, agricultural conservation program payment 11
Assistance:
  To friendly nations 203
  To promote conservation 17
Bank for Cooperatives, loans for storage structures 167
Barter or exchange of agricultural commodities:
  Charter provision 138, 179
  For foreign aid and assistance programs 179, 180
  For strategic commodities 138, 179
  For materials for offshore construction programs 217
  Transfer of commodities to—
    National stockpile 179
    Supplemental stockpile 180
Base, period for prices 3

Page
Basic agricultural commodities 154
Bond 80
Borrowing authority of CCC 138, 233
Bushel, defined 32
Butter:
  Price support 155
Buyer, collection and payment of penalty by 45, 77, 93, 97
Cancellation of debts 330
Cargo Preference Act 333
Carriers, common, records and reports required of 94
Carry-over, defined:
  Corn, cotton, peanuts, rice, tobacco, wheat 32–33
Certification of claimants 127
Certification, Food Stamp Program 323
Changes in cropping systems and land uses, agreements 18
Classification Act of 1949 ..... 2, 244
Commercial area, wheat 33
Commercial corn, producing area, defined 33
Committee, review. *See* Review committee.
Committees, local, county, and State:
  Establishment 5
  Expenses 12, 114
  Functions and utilization for—
    Agricultural adjustment 42, 56
    Commodity credit 140
    Federal crop insurance 245
    Soil Bank Act 127
    Soil conservation 5
    Sugar 274
Commodity Credit Corporation. *See also* Price support.
  Acquisition of plants and facilities 136
  Administrative expenses 139
  Advances for crop insurance premiums 113, 236
  Advances to Department agencies 235
  Allotment of funds to other agencies 141
  Annual report 141
  Board of directors 140
    Advisory board 140
  Borrowing authority 138, 233
  Bylaws, adoption of 136
  Capital stock 139
  Claims, authority to adjust and settle 138
  Cold storage facilities 137
  Conspiracy to commit offenses against 142
  Contracts and agreements 136
  Conversion of property of 142
  Cooperation with other agencies 140
  Corporate powers 135, 138
  Costs and expenses of donation programs 166
  Counterclaims 135
  Court of Claims, suit in 136
  Creation and purposes 135
  Crimes and offenses 141–142
  Cropping systems, changes in, and land uses, agreements 18
  Disposition of agricultural commodities:
    Barter 179–182
    Cotton for colleges 221
    Cotton for export 184–185
    Dairy products for armed forces 219
    Disaster relief 225–230
    Domestic disposal programs 217–224
    Export 175–178, 183–215
    Extra long staple cotton for export 184
    Famine relief 204

Commodity Credit Corporation. *See also* Price support—Continued Page
Disposition of agricultural commodities—Continued
Financing exportation of surplus agricultural commodities 195
Flour and cornmeal donations 220
Foreign currency 194
Legislative directive 183
Migratory waterfowl 231–232
Oil seeds, donations of 222
Processing, payment of costs of 212, 213
Restrictions on 160
Sales 139, 160, 183–186, 192
Sales price 160, 195
Section 32 159, 211
Surplus agricultural commodities 194
To foreign governments 192
Upland cotton 150
Dissolution of Delaware corporation 143
Effective date of Charter Act 143
Embezzlement of money, funds of 141
Exchange of commodities for foreign products 179–182
Exemption from legal process 135
Expansion and development of markets 139
Expenditures, authority to determine 138
Exportation of surplus commodities 178–179
Exporting agricultural commodities 139, 184–185
False statements to influence action of 141
Federal Property and Administrative Services Act, exemption from 237
Federal Reserve Banks, use of 235
Federal Tort Claims Act applicable 136
Free use of mails 136
General powers 135–138
Insurance on cotton 110
International Wheat Agreement 189–192
Interest of Members of Congress 141
Intervention in suits 135
Jurisdiction of courts 135
Larceny of property of 142
Legal history of 133
Limitation on actions 135
Liquidation of agricultural stocks 183
Loans and advances, authority to make 136, 137, 138
Loans, income tax on 237
Loans, nonrecourse 160
Location of offices 135
Making available surplus agricultural commodities 195, 204
Markets, expansion of 139
Munitions Board, Department of Defense 138
National School Lunch Act 311
Personal property, acquisition of 137
Personnel 140
Powers 135, 138
Price support authority 139
Procuring agricultural commodities 139
Purchasers of converted goods 143
Purposes 135
Real estate, acquisition of 137
Reconcentration of cotton 110
Records and reports 141
Regulations and rules, authority to adopt 136
Reimbursement by other agencies. *See* Reimbursement to CCC.
Removal or disposition of surplus commodities 139
Reports to Congress. *See* Reports by CCC to Congress.
Research, restrictions on 138
Restrictions on acquisition of real and personal property 137
Right to intervene in proceedings 135
Rights, privileges and immunities of, same as United States 136

Commodity Credit Corporation. *See also* Price support—Continued
Sales. *See* Sales by CCC.
Set-offs ... 136
Settlements, authority to make ... 138
Specific powers ... 138
State and local laws applicability ... 136
Statutes applicable to Corporation ... 139, 142, 237–239
Stimulating foreign production ... 238
Storage facility loans to grain producers ... 137
Strategic and Critical Materials Stock Piling Act ... 137, 179
Suits ... 135
Summary of legal history of Corporation ... 133
Supporting prices of agricultural commodities ... 138
Surplus disposal ... 139
Taxation ... 237
Transfer of assets of Delaware corporation ... 143
Use of funds and other assets ... 139
Usual custom of the trade ... 137, 139
Utilization of association and trade facilities ... 139, 141
Utilization of usual trade channels ... 137, 139, 189, 194, 219
Commodity Credit Corporation Charter Act, *see also* Commodity Credit Corporation ... 135
Commodity set-aside. *See* Set-aside.
Conditions for receiving payment or grant of aid ... 2, 4, 8, 269
Confidential records and reports ... 99
Congress, interest of members in contracts with the Government ... 141
Conservation materials and services, *see also* Grants of aid ... 1–4
Conservation measures, emergency ... 19
Conservation payments, special, for diverted acreage ... 19
Consultation on agricultural programs ... 328
Consumer safeguards ... 39
Consumption, normal domestic human ... 4
Consumption, normal year's domestic:
Defined—
Corn, cotton, tobacco, wheat ... 35
Rice ... 35
Container, identification ... 223
Container, sanitary ... 221
Cooperation for soil conservation, Government agencies ... 2
Cooperative associations, recognition and encouragement of ... 5
Corn:
Acreage allotments and marketing quotas ... 49–52
Acreage allotment for commercial area—
Amount of ... 52
Apportionment to counties ... 52
Apportionment of county allotment to farms ... 52
When proclaimed ... 51
Appeal relating to allotment, *see also* Review of acreage allotment
Definitions—
Actual production ... 32
Bushel ... 32
Carryover ... 32
Commercial corn-producing area ... 33
Farm consumption ... 34
Farm marketing quota ... 51
Market, marketed, for market ... 34
Marketing year ... 34
Normal production ... 34
Normal supply ... 34
Normal year's domestic consumption ... 35
Normal year's exports ... 35
Normal yield ... 35
Reserve supply level ... 37
Total supply ... 38

Corn—Continued Page
Acreage allotments and marketing quotas—Continued
Farm acreage allotments 52
Notice of farm acreage allotment 95
Pooled acreage allotments 102
Farm marketing excess 51
Farm marketing quota 51
Legislative finding 49
Price support level 151
Regulations issuance by Secretary 100
Reports and records required of buyers, warehousemen and others 98
Data confidential 99
Review of farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment 95
Acreage allotments under Soil Conservation and Domestic Allotment Act 6
Crop insurance. *See* Crop insurance.
Loans. *See* Price support.
Acreage requirement for price support 147, 150
Price support on 147–150
Parity payments 39
Transfer 76
Cornmeal, enrichment of 221
Cotton:
American upland:
Acreage allotments and marketing quotas 68, 69
Acreage planted, effect of, on agricultural conservation program payment 75
Adjustment of acreage planted to cotton 77
Appeal relating to farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment 91
Carryover 79
County acreage allotments—
Adjustments in 71, 72
Apportionment to old cotton farms 71
County cropland factor 71–72
Reserves for adjustments and new farms 72
Definitions—
Actual production 32
Carryover 32
Farm marketing excess 76
Market, marketed, for market 34
Marketing year 34
National average yield 34
Normal production 34
Normal supply 35
Normal year's domestic consumption 35
Normal year's exports 35
Normal yield, county and farm 35
Parity 29
Total supply 38
Domestic acreage allotments 80
Equalization payments 78
Excess acreage excluded from allotment calculations 75
Export market acreage 79
Farm acreage allotments—
Adjustments in old farm allotments 72
Adjustments in allotments for small farms 72
Apportionment of county allotment to old farms 71
Farms acquired for governmental use 102
Minimum, for old farms 74
New farms 74
Pooled acreage allotments 74
Release and reapportionment 102
Seventy-five percent planting rule 100

Cotton—Continued
American upland—Continued
Acreage allotments and marketing quotas—Continued
Farm marketing excess—
Adjustment in amount of 77
Amount of farm marketing excess 76
Producer subject to penalty on 77
Regarded as available for marketing 77
Farm marketing quotas—
Amount of farm quota 76
Increase or termination 97
Pooled acreage allotments 102
Identification of marketings 100
Legislative findings 68
Measurement of farms 99
National acreage allotment—
Amount of 69
Apportionment to States:
For 1953 and subsequent years 70
When proclaimed 70
National marketing quota—
Amount of 69
Conditions requiring proclamation of 69
Domestic and foreign-grown cotton 69, 177
Exemption of Extra long staple cotton from 77
Minimum national marketing quota 70
When proclaimed 70
Penalties—
Buyer to collect and pay 97
Exemption of marketings by experiment stations 98
Interest on unpaid penalty 77
Lien for, on entire cotton crop 77
Long staple cotton exemption 78
Producer subject to 77
Rate of penalty 77
Refund of penalty 98
Proclamations—
Increase or termination of marketing quotas 97
National acreage allotment 70
National marketing quota 69
Referendum results 70
Referendum—
Effect of results 70
Eligible voters 70
Notice of farm quota and allotment mailed prior to referendum 95
Proclamation of results 70
When conducted 70
Regulations, issuance by Secretary 100
Reports and records 98
Availability of data on allotments and quotas 98
Data confidential 99
Information required of ginners, buyers and others 98
Review of farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment 95
State acreage allotments—
Apportionments to counties 71
Minimum State allotment 71
Reserve for adjustments and new farms 71
Crop insurance. *See* Crop insurance.
Donation to colleges 221
Export sales 184

Cotton—Continued
American upland—Continued
Page
Extra long staple. *See* Extra-long staple cotton.
Insurance on 245
Loans. *See* Price support.
Parity payments 39
Predicting prices 342
Price support on 148
Reconcentration of 110
Sales for export 184
Sales to foreign governments 192
Standard grade 159
Extra long staple:
Export sales 184
Import quota 184
Price support 149
Sales for export 184
Long staple cotton:
Applicability of provisions of Act relating to acreage allotments and marketing quotas for cotton 77
Exemption of, from acreage allotments and marketing quotas for American upland cotton 78
National marketing quota—
Amount 77
Minimum national quota 78
When proclaimed 77
Rate of penalty 78
Varieties of long staple cotton 77
Cottonseed, price support 168
Cottonseed support level 156
County agricultural extension agent 5
County committee, election of 5
County committee, secretary to 5
County convention, election of delegates to 5
Court:
Jurisdiction 100, 244, 277
Review—
Marketing quotas 96
Sugar allotments 236
Crop insurance. *See also* Federal Crop Insurance Corporation.
Advances to producers 13
Agricultural commodities defined 248
Amount of insurance coverage 246
Claims for losses 248
Corn 246
Cotton 246
Cottonseed 248
Counties, number in which insurance to be offered 246
Criminal provisions applicable 250
Crops insured 246
Declaration of purpose 243
Failure to reseed to same crop or to follow good farming practices 247
Flax 246
Indemnities free from levy 248
Jurisdiction of courts on claims 247
Limitations on basis of risk involved 247
Minimum amount of participation 246
Multiple crop insurance 246
Premiums 247
Neglect or malfeasance of producer 247
Reinsurance for private companies 246
Risks insured against 246
Tobacco 246
Wheat 246

Page
Cropland:
Government owned, payments to 10
Leasing by government 10
Cropping systems, changes in, and land uses, agreements 18
Dairy products:
Availability to armed forces, Veterans Administration 219
Congressional policy 327
Domestic disposal 218
Price support 155
Data, latest available to be used 38
Death, incompetency, or disappearance, person entitled to payment 111, 274
Debts, compromising, adjusting or cancelling—
Applicable statutes and programs 330
Appropriation authorization 331
Conditions under which action authorized 330
Regulations, issuance by Secretary 330
Declaration of policy, Agricultural Adjustment Act of 1938 27
Deferred grazing program 11
Deficiency, loan collateral, liability for 160
Definitions:
Actual production 32
Adjusted base price 29
Affect interstate and foreign commerce 31
Agricultural commodity 12, 250
Bank 322
Basic agricultural commodity 163
Bushel 32
Carry-over 32–33, 164
Commercial corn-producing area 33
Cooperator 163
Corn 31
Coupons 321
Department 31
Direct-consumption sugar 255
Export market acreage 79
Farm consumption 34
Farm domestic allotment 80
Federal agency 225
Feed grains 20
Food 319
Food products 108
Friendly nations 203
Governor 225
Household 319
Interstate or foreign commerce 31
Liquid sugar 255
Local Government 225
Long staple cotton 77
Major disaster 225
Manufactured sugar 279
Market, marketed, marketing 34
Marketing year 34, 164
National average yield 34
National domestic allotment 80
Nonbasic agricultural commodity 164
Normal production 34
Normal supply 164
Normal year's domestic consumption 35
Normal year's exports 35
Normal yield 35, 37
Parity, prior to Agricultural Act of 1949 30
Parity, income 31
Parity index 30
Parity price 29

Definitions—Continued Page
Peanuts 94
Person 255, 279
Producer, sugar 256
Quota, sugar 256
Raw sugar 255
Raw value, sugar 255
Reserve supply level 37
Retail food store 320
Sanitary containers 222
Secretary 31, 256, 319
State 31, 225
State agency 320
Storable commodities 163
Sugars 255
Supply percentage 163
Surplus agricultural commodities 203
Tobacco 37
Total sugar content 256
Total sugars 280
Total supply 164
Transitional parity price 30
United States 31, 225, 280
Wholesale food concern 320
Demonstrational projects 1
Deposit of funds:
Crop insurance 248
Marketing penalties 45, 93, 97
Photographic reproductions 112
Determination by Secretary 19
Determinations, sugar 257
Disappearance, death, or incompetency, person entitled to payment 111, 274
Disaster relief:
Equipment, supplies 225
Feed 227
Diseases of animals, expense of eradication 335
Disposition of surplus agricultural commodities 139, 183–186, 217
Disqualification 323
District attorneys, enforcement of Sugar Act by 274
District courts, jurisdiction of 100, 244, 276
Diverted acreage:
Corn 52
Rice 82
Tobacco 42
Use 17
Wheat:
Penalty 65
Domestic acreage allotments, cotton 80
Domestic marketing certificate 105
Donation:
Domestically before foreign currency sales 224
For disaster relief 225–230
For home economics courses 220
Generally 217–218
Identification on containers 223
Of animal fats 222
Of dairy products 218
Of flour and cornmeal 221
To areas under U.S. jurisdiction 222
To colleges 221
To penal instutions 221
To school lunch program 311–318
To trust territories of the United States 215
Donor identification 223
Educational exchange, financing of international 199
Election of local and county committees 5

Page
Eligibility to vote in committee elections ---- 5
Emergency area ---- 225
Eminent domain ---- 101
Enforcement—Agricultural Adjustment Act of 1938 ---- 100
Enforcement—Food Stamp Act ---- 325
Enrichment of cornmeal, grits and white flour ---- 221
Equalization payments ---- 78
Expansion of international trade ---- 193
Export market acreage ---- 79
Export, sales for—
  Cotton ---- 184
  Extra-long staple cotton ---- 184
Extension Service ---- 274
  County agent ---- 5
  State director ---- 5
Extra-long staple cotton: See Cotton.
Factors, feed grain bases ---- 20
Facts constituting bases for agricultural conservation program payment, sugar or parity payment, loan, or price support, conclusiveness of ---- 14, 111, 273
Fair prices for conservation materials and services ---- 6
Famine relief:
  CCC surplus commodities for ---- 204–206
  Marking, as from U.S ---- 207
Farm, definition of, for purposes of sugar payments ---- 272
Farm domestic allotment ---- 80
Farm marketing excess:
  Cotton ---- 76
  Rice ---- 87
  Wheat ---- 62
Farm marketing quotas. *See* Corn, Cotton, Peanuts, Rice, Tobacco, Wheat.
Farms, small, provisions relating to ---- 41, 94
Federal agricultural services ---- 329
Federal Crop Insurance Act ---- 243
Federal Crop Insurance Corporation:
  Accounting by ---- 249
  Actions on claims ---- 247
  Advances by CCC for payment of premiums ---- 13
  Advances to pay crop insurance ---- 236
  Advisory committee ---- 250
  Allotment of funds to bureaus, offices, and agencies ---- 245
  Annual reports ---- 249
  Appropriation, authorization for administrative costs ---- 250
  Audit of accounts by General Accounting Office ---- 249
  Board of Directors ---- 244
  By laws, adoption of ---- 244
  Capital stock ---- 243
  Claims for losses ---- 247
  Compensation, injured employees ---- 245
  Corporate seal ---- 244
  Court action, by and against ---- 244
  Creation ---- 243
  Crimes and offenses ---- 249
  Deposit of funds ---- 248
  Employees to furnish bonds ---- 245
  Exemption from legal process ---- 244
  Exemption from taxation ---- 249
  Expenditures, authority to determine ---- 245
  Fiscal agent of Government ---- 249
  Free use of mails ---- 244
  Funds, deposit and investment ---- 248
  General powers of Corporation ---- 244
  Incidental powers ---- 245
  Indemnities, payment of ---- 247

Federal Crop Insurance Corporation—Continued Page
Location, principal office 243
Management 243
Manager 243
Non-administrative and nonoperating expenses 250
Offset purchases and sales 248
Personnel 245
Premium rates 247
Premium reserves 247
Premiums, collection or payment of 247
Publication of list of indemnities paid 247
Purchase, handling, and sale of agricultural commodities 248
Purpose of Act 243
Regulations 250
Report to Congress 249
Research, surveys, and investigations 245
Right to amend Act 250
Separability 250
Tax exemption 249
Utilization:
Cooperative associations 245
Local committees or associations 245
Federal Property and Administrative Services Act 237
Feed for livestock 226
Feed grain 19
Fees, import 211
Finality of determinations 14, 128, 165, 275
Financing exports of surplus commodities 195
Fines and forfeitures:
Agricultural Adjustment Act of 1938 97
Federal Crop Insurance Corporation 251
International Wheat Agreement 191
Soil Bank Act 129
Sugar Act 276
Flour, enrichment of 221
Food stamp plan, legislative directive 183
Food Stamp Act 319
Foreign currency, sales for under Public Law 480:
Deposit of currency in special account 202
Domestic donations before 224
Rates of exchange 203
Report to Congress 203
Use of currency 197, 201
Foreign markets, expansion of 13, 194, 329
Foreign production, stimulation of 238
Freight, ocean, payment of 196, 205
Freight rates, adjustment of 27
Friendly nations:
Assistance to 206
Definition 203
Sales to, for foreign currency 194
Trade with 327
Goats:
Advertising and sales promotion programs 172
Price support on mohair 170
Government-owned cropland, payments on 10
Grits, enrichment of 221
Grants of aid:
Assignment of payments earned 11
Increase of small payments 10
Ten-thousand-dollar limitation 10
Grants to agricultural producers, conditions of payment 8
Great Plains conservation program 15
Acreage preservation 15
Guam 329

Page
Hearings:
Adjustment of marketing quotas 97
Imports 284
Parity prices 30
Price support level 163
Review Committee 95
Sugar 278
Home economic courses, surplus commodities for 220
Humane slaughter of livestock 333
Honey 155
Hops 296
Identification of surplus food containers 223
Imports quotas and fees under Section 22 of Agricultural Adjustment Act of 1933 284
Agreements with foreign governments 284
Extra-long staple cotton 184
Imports and exports:
Farm commodities, investigation of cause of reduction of exports 29
Meat and livestock 286
President's authority under Section 22 of Agricultural Adjustment Act of 1933 284
See also Sugar.
Incompetency, death, or disappearance, person entitled to payment 274
Income tax, on CCC loans 237
Incorrect information under Soil Bank 130
Innocent purchasers of converted goods 143
Insurance on cotton 248
Intergovernmental organizations, use of 204
International Wheat Agreement, 1956 192
International Wheat Agreement Act of 1949 189
Appropriation authorization 191
Fines and forfeitures 191
Jurisdiction of courts 191
Person, defined 192
Regulations and rules, issuance by President 190
Utilization of Commodity Credit Corporation 189
Interstate Commerce Commission:
Department of Agriculture, cooperation 28
Farm products, prosecution of complaints by Secretary of Agriculture 27, 28
Hearings before 28
Investigations 1, 9, 10, 12, 33, 97, 245, 278
Land uses, changes in, and cropping uses, agreements 18
Landlords, tenants, or sharecroppers 5, 9
Laws, miscellaneous 283
Letters of commitment, sales for foreign currency 195
Limitations on actions 135
Limitations, payments under agricultural conservation program 9
Liquidated damages 80
Livestock:
Humane slaughter 333
Preservation and maintenance 176
Livestock and poultry producers, protection of income of 9
Livestock feed, sugar 280
Loans for storage facilities 137, 167
Loans, income tax on CCC 237
Loans, on agricultural commodities. *See* Price support.
Local administrative areas 5, 83, 95
Local and county committees. *See* Committees.
Long staple cotton. *See* Cotton.
Long-term supply contract 207
Manufacturers, sugar tax 279
Maps, furnished to governmental agencies 112
Market, marketing, or marketed, definition of 34

Page

Marketing agreements and orders:
- Anti-trust laws, exemption from 291
- Blended milk prices 294
- Books, keeping of 303
- Commerce, interstate or foreign, defined 307
- Commodities for which orders may be issued 291
- Confidential information, penalties 303
- Cooperation with State authorities 307
- Forfeitures 300
- Fruit and vegetable orders 292
- Hearing on order 293
- Marketing agreements 291, 297
- Marketing control:
  - Commodities other than milk and its products, methods 294–295
  - Milk and its products, methods 293
- Marketing order, issuance 291
- Marketing policy 289
- Milk marketing orders 293
- Milk order prices 302
- Milk programs 293
- Notice of proposed order 293
- Orders:
  - Arbitration of disputes 309
  - Authority to issue 291
  - Commodities other than milk or its products, terms of 294–295
  - Cooperative approval, of, as approval of producer 300
  - Exemption from 300
  - Finding of Secretary 293
  - Imported commodities, restrictions of 304
  - Marketing agreement with 296
  - Marketing agreement, with or without 298
  - Milk or its products 293
  - Producer and processor, approval of 298
  - Referendum for approving 302
  - Regional basis, applicability on 299
  - Representation of cooperatives 300
  - Terms and conditions of 293
- Penalties for violation of order 300, 307
- Petition by handler, court review of Secretary's ruling 300
- Petition by handler for modification of order or exemption 300
- Policy 289
- Products covered by 301
- Purposes of program 289
- Records, keeping of 303
- Speculation forbidden 307
- Termination of 301
- Violation of orders 300, 307

Marketing certificates 105

Marketing penalties. *See* Penalties.

Marketing quotas:
- Adjustment of quotas and enforcement 97
- Commodities subject to—
  - Cotton 69
  - Peanuts 89
  - Rice 87
  - Tobacco 40, 153
  - Wheat 52, 61, 154
- Review of farm marketing quotas by review committees 95

Marketing year:
- Corn 34
- Cotton 34
- Peanuts 34
- Rice 34
- Tobacco 34

Page
Marketing year—Continued
Wheat 34
Wool and mohair 172
Measurement of farms 99
Migratory waterfowl, grain for 231
Military equipment, etc., procurement of 198
Milk:
Arbitration of dispute concerning 309
Marketing orders 293–294
Policy of Congress 327
Prices 155
Program to increase consumption of 218, 328
Miscellaneous laws 283
Mohair:
Advertising and sales promotion programs 172
Marketing year 172
Price support 170
Mosaics, furnished to governmental agencies 112
Multilateral trade loans 198
National acreage allotment:
Cotton 70
Peanuts 89
Rice 82
Wheat 52
National domestic allotment 80
National School Lunch Act. *See* School lunch program.
National average yield. *See* Yield.
National Industrial Recovery Act 2
National marketing quota:
Cotton 69
Peanuts 89
Tobacco 40
Wheat 54
Amount 54
National stockpile. *See* Stockpile.
National Wool Act of 1954. *See* Wool.
Naval stores conservation program 11
New farms:
Cotton 71
Peanuts 90
Rice 82
Tobacco 42
Wheat 58
New or expanded markets 13
Noncooperator, price support 148
Normal production. *See* Production.
Normal supply. *See* Supply.
Normal year's domestic consumption. *See* Consumption.
Normal year's exports. *See* Exports.
Normal yields. *See* Yield.
Notice, farm marketing quota and acreage allotment, mailed to farmer prior to referendum 95
Nursery stock, appropriation authorized 3
Obligations, limitation of, for agricultural conservation 15
Ocean freight charges 196
Officers and employees, appointment and compensation. *See* Appointment of officers and employees.
Parity, definition of (prior to Agricultural Act of 1949) 29–30
Parity (Agricultural Act of 1949):
Cotton, standard grade for purposes of 159
Definitions—
Adjusted base price 29
Parity index 30
Parity price—
Determination of 29

Parity (Agricultural Act of 1949)—Continued Page
Parity price—Continued
Hearings on revision 30
Minimum, for 6 years beginning Jan. 1, 1950 30
Wartime subsidy payments included 30
References to, meaning of 29, 31
Parity payments 39
Payment-in-kind certificate 22
Payments:
Advance, agricultural conservation program 5, 113
Agricultural conservation program 15, 18
Assignment of 11
Cotton equalization 10
Cropland owned by United States 10
Division of, between landlords, tenants and sharecroppers 10
Finality of determinations 14
In-kind 22
Naval stores conservation program 11
Parity 39
Producers displaced by war effort 9
Sharing in by tenants and sharecroppers 8
Small, increase in 9–10
Soil Bank Act 112
Soil Conservation and Domestic Allotment Act 4, 8
Sugar 267
Ten-thousand-dollar limitation 10
Peanuts:
Acreage allotments and marketing quotas—
Appeal of farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment 95
County acreage allotments 90
Definitions—
Actual production 32
Carry-over 32
Market, marketed, for market 34
Marketing year 34
Normal supply 34
Normal yield, county and farm 35–36
Peanuts 94
Total supply 38
Excess acreage excluded from future allotment calculations 92
Exemptions of farms harvesting one acre or less 94
Farm acreage allotments—
Apportionment of county allotment to old farms 94
Apportionment of State allotment to old farms 94
Farms acquired by Government under eminent domain powers 102
New farms 92
Pooled acreage allotments 102
Reduction in, for violation 93
Release and reapportionment of farm allotments 92
Seventy-five percent planting rule 101
Farm marketing quotas—
Amount of farm quota 89
Identification of marketings 100
Legislative findings 89
National acreage allotment—
Amount of 89
Apportionment to the States 90
Conversion of national quota to 90
Minimum national acreage allotment 90
Reserve for new farms 91
National marketing quota—
Amount 90
Conversion to national acreage allotment 90

Page

Peanuts—Continued
Acreage allotments and marketing quotas—Continued
National marketing quota—Continued
Minimum national marketing quota ---- 90
Proclamation of ---- 90
Penalties, penalty—
Buyer to pay ---- 93
Buyer and producer jointly and severally liable for ---- 93
Deposit of penalties ---- 93
Failure to account for disposition of peanuts ---- 93
False identification ---- 93
Marketing in excess of farm quota, subject to ---- 93
Payment of penalty by producer ---- 93
Percent method of collecting ---- 94
Rate of penalty ---- 93
Refund of ---- 94
No refunds based on peanuts used for seed or home consumption ---- 94
Proclamations—
National marketing quota ---- 90
Results of referendum ---- 90
Referendum—
Effect of results ---- 90
Eligible voters ---- 90
Proclamation of results ---- 90
When conducted ---- 90
Regulations, issuance by Secretary ---- 100
Release and reapportionment of farm acreage allotments ---- 92
Reports and records ---- 98
Data confidential ---- 99
Review of farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment ---- 95
State acreage allotment—
Apportionment to old farms ---- 91
Apportionment to counties ---- 91
Penalty, marketing:
Exemption of crops marketed by experiment stations ---- 98
Payment, collection, and refund of penalties, *see also* Corn, cotton, peanuts, rice, tobacco, wheat ---- 97–98
Rate of penalty—
Cotton ---- 77
Peanuts ---- 93
Rice ---- 88
Tobacco ---- 45
Wheat ---- 62
Unauthorized use of feed ---- 228
Perishable agricultural commodity ---- 158, 212
Person, defined ---- 31, 192, 255, 279
Personnel:
Agricultural Adjustment Administration ---- 112
Commodity Credit Corporation ---- 140
Federal Crop Insurance Corporation ---- 245
International Wheat Agreement Act ---- 191
Soil Conservation Service ---- 2
Sugar Act ---- 275
Photographic reproductions, mosaics, and maps, furnishing of, to governmental agencies and others ---- 112
Policies and purposes:
Agricultural Act of 1954 ---- 327
Agricultural Act of 1961 ---- 327
Agricultural Adjustment Act of 1938 ---- 27
Commodity Credit Corporation Charter Act ---- 135
Federal Crop Insurance Act ---- 243
Food and Agriculture Act of 1962 ---- 327

Policies and purposes—Continued Page
Soil Bank Act 177
Soil Conservation and Domestic Allotment Act 1
Preservation of acreage 101
Price support:
Amount, terms, and conditions 157
Commodity Credit Corporation—
Authority to sell commodities 160, 175
Authority to support prices, charter provision 135
Disposition of commodities deteriorating or spoiling 161, 163
Disposition of commodities to prevent waste 217–218
Restrictions on sales 175
Sales policies 175
Secretary to provide price support through 157
Utilization of, in Section 32 programs 159
Conditional on—
Marketing quota, marketing agreement or order program 158
Cottonseed 156, 168
Definitions—
Basic agricultural commodity 163
Carryover, nonbasic agricultural commodity 164
Cooperator 163
Marketing year 164
Nonbasic agricultural commodity 163
Normal supply, nonbasic agricultural commodity 164
Storable commodities 163
Supply percentage 163
Terms defined in Agricultural Adjustment Act of 1938 164
Total supply, nonbasic agricultural commodity 164
Eligibility for price support—
Compliance with allotments, goals, practices, quotas 158
Factors governing availability of price support 158
Finality of determinations 111, 165
Level of price support—
Adjustment for grade, location, etc 159
Advance announcement of 160
Basic agricultural commodities 147
Conditions 158
Corn 151
Cotton and peanuts 148
Long staple cotton 149
Noncooperators 148
Tobacco 147
Wheat 147
Designated nonbasic agricultural commodities—
Honey 155
Milk (whole), butterfat, and products 155
Tung nuts 155
Wool (including mohair) 170
Factors considered in determining 158
Increasing, after public hearing 159
Loans 147–155
Loans taxable as income 237
Nonrecourse loans 160
Other nonbasic agricultural commodities 156
Parity prices used in determining 158
Private channels of trade, use of 137
Producer's liability for deficiencies, etc 160
Reconcentrating and insuring cotton 110
Processed food products 220
Processor programs 159
Proclamations:
Imports 285
Marketing quotas—
Cotton 69

Page
Proclamations—Continued
Marketing quotas—Continued
Peanuts 90
Rice 87
Tobacco 41
Wheat 64
Procurement costs, reimbursement for 235
Producers, small, protection of 4
Production and Marketing Administration:
Delegation of powers to 13
Organization of 13
Production:
Actual—
Corn 32
Cotton 32
Peanuts 32
Rice 32
Wheat 61
Normal—
Corn 34
Cotton 34
Rice 34
Wheat 34
Proportionate shares:
Conservation of resources, Puerto Rico 273
Sugar 270
Public Law 480, 83d Cong 193
Publication and review of farm marketing quota 95
Purchase agreements. *See* Price support.
Purchase orders for conservation materials and Services 6
Purchases. *See* Price support.
Purchases, advance, of conservation materials and services 5–6
Purchasing power, ratio of farm and nonfarm 3
Quotas. *See* Import quotas, Marketing quotas, and Sugar Act of 1948.
Rate of conservation payments 9
Reconcentration of cotton 110
Records, availability of Department 99
Records and reports—
Administrator of Veteran Affairs, report to Congress 219
Agriculature Adjustment Act of 1938 98
Agriculatural conservation operations, report to Congress 12
Commodity Credit Coporation, annual report 141
Federal Crop Insurance Corporation 249
International Wheat Agreement 189
Marketing agreements and orders 303
Wheat marketing allocation 109
Redemptions 322
Referendum:
Commodities to which applicable—
Cotton 70
Peanuts 90
Rice 87
Tobacco 40
Wheat 64
Wool 172
Notice of farm quota and allotment mailed prior to referendum 95
Refunds:
Marketing quota penalties 98
Taxes on sugar 279
Regional research laboratories:
Establishment and maintenance 28
Regulations:
Acreage allotments and marketing quotas 97
Agriculatural conservation 2

Regulations—Continued Page
Committees, selection and functions 5
Commodity Credit Corporation 135
Corn 100
Cotton 100
Crop insurance 242
Debts, compromising, adjusting, or canceling 330
International Wheat Agreement 191
Issurance by Secretary 100
Peanuts 100
Rice 100
Soil Bank Act 129
Soil conservation 2
Sugar 275
Tobacco 100
Wheat 100
Reimbursement to CCC:
By other agencies for foreign currency 203
By other agencies for services 235–236
Dairy products 219
Disaster and distress relief 225–230
Grain for waterfowl 231
Net realized loss, 1961 233
Payments to wool producers 171
Public Law 480 exports 195–196
Procurement costs 235
Transfers to stock pile 138
Use of personnel and facilities by other agencies 140
Reports. *See* Records and reports.
Reports by CCC to Congress:
Agricultural Trade Development and Assistance Act 203
Annual report 141
Disposal of CCC stocks 183
Public Law 480 sales 203
Research laboratories 28
Reserve supply level. *See* Supply.
Restrictions on land use. *See* Practices.
Review committee, appointment and compensation of members 95
Review of farm marketing quota and acreage allotment:
Application for review 95
Publication and notice of farm quota and allotment 95
Review by court of review committee determination 96
Review of payments or grants only by Secretary 14
Rice:
Acreage allotments and marketing quotas—
Appeal of farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment 95
County acreage allotments—
Apportionment to old farms 85
Death of producer, apportionment in case of 86
Definitions—
Actual production 32
Carry-over 32
Market, marketed, for market 34
Marketing year 34
Normal production 34
Normal supply 34
Normal year's domestic consumption 35
Normal year's exports 35
Normal yield 36
Total supply 38
Exemptions—
Farms planting 3 acres or less to nonirrigated rice 85
Rice produced outside continental United States 85
Excess acreage excluded in future allotment calculations 84

Rice—Continued
Page
Acreage allotments and marketing quotas—Continued
Farm acreage allotments—
Allotments for new farms ---- 82
Allotments for new producers ---- 82
Death of producer, apportionment in case of ---- 86
Established on basis of producer's rice history ---- 83
Established on basis of rice history on farm ---- 83
National reserve for adjustments in, for old and new farms ---- 82
Past production, determination upon basis of ---- 83
Seventy-five percent planting rule ---- 101
Farm marketing excess—
Adjustment in amount of ---- 88
Definition of ---- 88
Disposition of rice delivered to Department ---- 88
Pooled acreage allotments ---- 102
Producer subject to penalty on ---- 88
Reduction of stored amount by underplanting or producing sub-normal crop ---- 88
Regarded as available for marketing ---- 88
Regulations governing delivery or storage ---- 88
Representative grades to be stored unless otherwise provided 88
Farm marketing quotas—
Amount of farm quota ---- 87
Increase or termination ---- 97
Identification of marketings ---- 100
Legislative findings ---- 81
Marketing quotas—
Conditions requiring proclamation of ---- 87
When proclaimed ---- 87
Measurement of farms ---- 99
National acreage allotment—
Amount of ---- 82
Apportionment among States ---- 82–83
Reserve acreage for old and new farms ---- 82
When proclaimed ---- 82
Past production, determination on basis of ---- 86
Penalties, penalty—
Exemption of rice marketed by experienced stations ---- 98
Interest on unpaid penalty ---- 88
Lien for, on entire crop ---- 88
Marketings subject to, until excess stored or delivered ---- 88
Producer subject to penalty ---- 88
Rate of penalty ---- 88
Refund of ---- 88
When due ---- 99
Price support level ---- 88
Proclamations ---- 147
Referendum— ---- 87
Effects of results ---- 87
Eligible voters ---- 87
Proclamation of results ---- 87
When conducted ---- 87
Regulations, issuance by Secretary ---- 87
Reports and records ---- 100
Data confidential ---- 98
Review of farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment ---- 98
State acreage allotments— ---- 95
Apportionment to farms of old producers ---- 82–83
Apportionment of old farm ---- 82–83
Establishment and adjustment of county allotments ---- 84
Reserves for new farms and new producers ---- 83
Transfer, conditions ---- 86

Page
Sanitary containers 221
School lunch program:
Accounts and records 316
Administrative expenses 312
Agreements between States and schools 313
Agreements with States 313
Apportionments 311
Appropriations 311, 337
Certification to Treasury of payments to States 313
Declaration of policy 311
Direct distribution 312
Disbursements to schools 313
Food costs defined 314
Imposition of teaching requirements prohibited 317
Matching funds 313
Nonfood assistance 312
Nonfood assistance defined 317
Nonprofit private school defined 317
Nutritional requirements 314
Private schools 314
Program requirements 314
Records 316
School defined 318
Section 32 commodities to schools 312
State defined 317
State educational agency defined 317
Utilization of CCC services 159
Secretary of Agriculture, defined 31
Secretary of Commerce, promotion of sale of farm commodities by 29
Section 32 of Pub. Law 320, 74th Cong., *see also* Appropriations 211
Advance payments to Commodity Credit Corporation 159
Availability of funds, Administrative expenses 211
Distribution of fish products 213
Domestic consumption, encouragement of 211
Exportation, encouragement of 211
Finalty of Secretary's determinations 211
Limitation on funds for a commodity 211
Purchasing power, reestablishment of farmers' 211
Supplemental appropriation 213
Utilization of Commodity Credit Corporation 159
Section 22 of the Agricultural Adjustment Act of 1933 284
Separability of provisions:
Agricultural Adjustment Act of 1938 113
Federal Crop Insurance Act 249
Services and facilities of CCC, use of by Secretary 159
Set offs 135
Settlement of indebtedness 138
Sharecroppers. *See* Landlords, tenants, or sharecroppers.
Sheep:
Advertising and sales promotion 172
Price support on wool 170
Shipping, cargo preference 332
Slaughter, humane 333
Small farms and small producers 5
Soil Bank Act 117
Acreage reserve program 118
Compensation of producers 120
Effect on acreage allotments and quotas 121
Extent of participation in program 119
Removal of hay, special circumstances 121
Conservation reserve program 121
Authorized period of contracts and expenditures 124
Conservation reserve goal 124
Effect on other programs 126
Geographical applicability 126

Page

Soil Bank Act—Continued
Conservation reserve program—Continued
Termination and modifications of contracts 125
Terms and conditions 121
Declaration of policy 117
General provisions 126
Certificate of claimant 127
Compliance with acreage allotments 126
Finality of determination 128
Financing 128
Incorrect information 130
Penalty for grazing or harvesting 129
Pooling of conservation reserve land 129
Protection of tenants and sharecroppers 129
Reapportionment prohibited 127
Regulations 129
Utilization of land use capability data 128
Utilization of local and State committees 127
Utilization of other agencies 128
Soil-building practices. *See* Practices.
Soil Conservation and Domestic Allotment Act 1
Acreage allotments and normal yields 6–7
Advances for crop insurance 13
Appropriations for fiscal year 1965. *See also* Appropriation Act 338
Assignment of payments 11
Availability of funds 12
Certificates of claimants 14
Conservation materials and services 6
Deferred grazing program 11
Grants of aid 4
Naval Stores Conservation program 11
Payments or grants of aid 4
Policies and purposes 3
Scope of Act 1
Soil Conservation Service:
Establishment, powers and duties 2–3
Authority to sell supplies, materials, and equipment to other Government activities 3
Soil-depleting practices. *See* Practices.
Soybeans, price support on 156
Special acreage reserve 56
Special deposit account 98
Peanuts 93
Tobacco 42
Standards 320
State, defined 23, 31
State agency 322
State committee 5
State laws, applicability to CCC 136
Statistics, latest available to be used 38
Statistics, use of official 257
Steagall amendment 145
Stockpile, transfer of bartered commodities to 138, 179–182
Stockpiling of agricultural products 183
Storage amount:
Rice 87
Storage facilities, loans for 137, 167
Strategic and Critical Materials Stock Piling Act 138
Stratgeic materials:
Barter for 138, 206, 217
Purchase by other agencies 206
Purchase under Public Law 480 198
Transfer to stockpile 138, 179
Transfer to supplemental stockpile 180, 198

Page
Strategic stockpiling of agricultural commodities 183
Sugar Act of 1948:
Appropriation authorization 338
Appropriations for fiscal years 1964–65. *See* Appropriations.
Civil penalties for violation of Act 276
Definitions—
Direct-consumption sugar 255
Including, include 256
Liquid sugar 255
Manufactured sugar 279
Manufacturer 279
Person 255, 279
Producer 256
Quota 256
Raw sugar 255
Raw value 255
Secretary 256
Sugar 255
Sugars 255
Total sugar content 256
Total sugars 280
United States 257, 280
Diplomatic relations, discontinuance 260
District attorneys of United States to enforce 276
Expenditures by Secretary 275
Finality of determinations 275
Fines and forfeitures 276
Import fees 268
Information to be furnished Secretary 276
Investments and business interests by officials prohibited 277
Jurisdiction of courts 276
National economic or other emergency, existence of, as basis for suspending quotas 276
Payments—
Abandonment of planted acreage, as basis for 273
Adherent planters 272
Application for 274
Appropriation authorization for 275
Areas in which payment provisions applicable 275
Base rate of payment 273
Calculation of 273
Compliance with provisions relating to—
Child labor 269
Proportionate share for farm 270
Wages and wage rates 270
Conditions in respect to 269
Crop deficiencies of harvested acreage, as basis for 273
Death, disappearance or incompetency 274
Designation of payee by producers 274
Establishment of proportionate shares for farms 270
Farm, to be defined by Secretary 274
Finality of determination with respect to 275
New and small producers 271
Utilization of local committees and other agencies 274
Proportionate shares 272
Puerto Rico 273
Quotas:
Allotments of quotas or prorations—
Appeal of allotment 263
Basis for allotments 262–263
Hearings 264
Area quotas—
Cuba 259, 266
Domestic beet sugar 258
Mainland cane sugar 258

Page

Sugar Act of 1948—Continued
Quotas—Continued
Area quotas—Continued
Hawaii 258, 265
Other foreign countries 258–259
Puerto Rico 258, 265
Republic of Philippines 258
Virgin Islands 258, 265
Consumption estimates, determination of, for—
Continental United States 257
Hawaii and Puerto Rico 261
Deficits, proration of quota 262
Exemptions from quota provisions 268
Exportation of sugar from United States—
Entry of sugar under bond 267
Expressed in terms of raw value 267
Filling quotas with direct-consumption sugar—
Hawaii 265
Puerto Rico 265
Republic of the Philippines 266
Virgin Islands 265
Suspension of direct-consumption portions of quotas 277
Liquid sugar, inclusion in determinations 267
Local consumption quotas for Hawaii and Puerto Rico 261
Prohibited acts 267
Secretary to establish or revise existing quotas 257
Suspension 277
Regulations, determinations and orders, issuance by Secretary 275
Publication in Federal Register 275
Surveys and investigations 278
Information on individual operations confidential 278
Suspension of quotas 277
Taxes, excise (provisions of Internal Revenue Code)—
Applicability of other laws 279
Definitions 279
Distillation 280
Exemption 280
Exportation 280
Filing of return and payment of tax 279
Investments and business interests by officials prohibited 281
Livestock feed 281
Manufactured sugar 279
Personal consumption 279
Manufactures 279
Rate, manufactured sugar 279
Termination of Sugar Act 277
Supplemental stockpile:
Transfer of bartered commodities to 177–182
Purchase for, under Public Law 480 179
Reimbursement to CCC 195–196
Supply:
Normal—
Corn, cotton, peanuts, rice, tobacco, wheat 34
Nonbasic commodity 163
Reserve level, corn and tobacco 37
Total—
Corn, peanuts, rice, wheat 38
Cotton 38
Tobacco 38
Supply contracts 208
Surplus commodities, disposition of 183
Surplus disposal, CCC 139, 183, 195, 204
Appointment of administrator 187
Legislative directive 183
Report to Congress 183
Surveys and investigations 1, 10, 12, 29, 33, 97, 245, 278

Page

Suspension of quotas. *See* Termination of quotas.
Tariff Act of 1930 ---- 285
Tariff Commission, United States ---- 285
Taxation. *See* Federal Crop Insurance Act and Sugar Act of 1948.
Tenants. *See* Landlords, tenants, or sharecroppers.
Ten-thousand-dollar limitation on payments ---- 10
Termination of feed grain program ---- 22
Termination or suspension of quotas ---- 97, 277
Territorial application of acts:
  Soil Bank Act ---- 127
  Soil Conservation and Domestic Allotment Act ---- 1
  Sugar Act of 1948 ---- 275
Tobacco:
  Acreage allotment and marketing quotas—
    Appeal relating to farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment ---- 95
    Definitions—
      Carryover ---- 33
      Market, marketed, for market ---- 34
      Marketing year ---- 34
      Normal supply ---- 35
      Normal year's domestic consumption ---- 35
      Normal year's exports ---- 35
      Parity ---- 31
      Reserve supply level ---- 37
      Tobacco ---- 37
      Total supply ---- 38
    Farm acreage allotments—
      Apportionment of State allotments to old farms ---- 41–42
      Increases in, for small farms ---- 42
      Increases in, for types in short supply ---- 44
      Minimum, for Burley farms ---- 44
      New farms ---- 44
      Notice of farm acreage allotment ---- 95
      Pooled acreage allotments ---- 102
      Reduction in, for violation ---- 44
      Seventy-five percent planting rule ---- 101
    Farm marketing quotas—
      Amount of farm quota when farm allotments established ---- 40
      Apportionment of State quota to old tobacco farms ---- 41
      Increase in, for small farms ---- 41
      Increase in, for types in short supply ---- 44
      Increase or termination ---- 97
      Lease and transfer of ---- 48
      New farms ---- 42
      Notice of farm marketing quota ---- 95
    Identification of marketings ---- 100
    National marketing quota—
      Amount of ---- 40
      Apportionment to States ---- 41
      Increase in, under specified conditions ---- 41
      When proclaimed ---- 41
    Penalties, penalty—
      Carryover tobacco ---- 45
      Deposit of penalties ---- 45
      Disposing of excess tobacco to avoid ---- 45
      Exemption of tobacco marketed by experiment stations ---- 98
      Failure to account for disposition of tobacco ---- 45
      False identification ---- 45
      Marketings outside United States ---- 45
      Marketings prior to beginning of marketing year ---- 45
      Marketings subject to penalty ---- 45
      Payment of, by buyer, warehouseman, agent ---- 45
      Rate of penalty ---- 45
      Refund of penalty ---- 98

Tobacco—Continued
Acreage allotment and marketing quotas—Continued
Page
Proclamations 40
Referendum—
Effect of results 41
Eligible voters 41
Notice of farm quota and allotment mailed prior to referendum 95
Proclamation of results 41
When conducted 41
Regulations, issuance by Secretary 100
Reports and records 98
Data confidential 99
Review of farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment 95
State acreage allotment—
Apportionment to old farms 41
Conversion of State quota to 42
State marketing quota—
Apportionment to old farms 43
Conversion of, to State acreage allotment 43
Minimum, for flue-cured tobacco 43
Reserve for new and small farms 42
State poundage allotment 43
Legislative finding 39
Loans. *See* Price support.
Parity payments 39
Price support level 147–148
Total supply. *See* Supply.
Trade agreement 284
Transfer of quotas:
Tobacco 43
Wheat 65
Tung nuts 155
Unfriendly nations 206
United States, definition of 31, 257
Utilization of State and local agencies 4, 245, 274
Vendors of conservation materials and services 5–6
Violations 325
Voluntary relief agencies, use of 204
Wage, rates, sugar 270
Water conservation 4
Waterfowl, migratory 231–232
Wheat:
Acreage allotments and marketing quotas—
Acreage allotments under Soil Conservation and Domestic Allotment Act 6, 7, 56
Appeal relating to farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment 95
County acreage allotments—
Apportionment to old farms 57
Definitions—
Actual production 32
Carryover 33
Farm marketing excess 62
Market, marketed, for market 34
Marketing year 34
National average yield 34
Normal production 34
Normal supply 34
Normal year's domestic consumption 35
Normal year's exports 35
Normal yield, county and farm 36
Total supply 38
Farm acreage allotments—
Apportionment of county allotment to old farms 57

Wheat—Continued Page
Acreage allotments and marketing quotas—Continued
Farm acreage allotments—Continued
Commercial area 60
New farms 57
Notice of farm acreage allotment 95
Pooled acreage allotments 102
Reduction 44
Seventy-five percent planting rule 101
Farm marketing excess—
Application for adjustment of stored amount 62
Definition of 62
Disposition of wheat delivered to Secretary 62
Failure to deliver or store 63
Regarded as available for marketing 62
Regulations governing delivery or storage 62
Farm marketing quotas—
Effect of termination 97
Increase or termination 97
Notice of farm marketing quota 95
Regulations, issuance by Secretary 100
Small farm exemption 61
Transfer of quotas 65
Identification of marketings 100
Land use 17
Legislative findings 52
Measurements of farms 99
National acreage allotment—
Amount of 55
Apportionment to States 56
National marketing quota—
Amount of 53
Conditions requiring proclamation of 54
Increase or termination 97
Penalties, penalty—
Application for adjustment of 62
Buyer to collect and pay 97
Lien for, on entire crop 63
Marketings subject to, until excess stored or delivered 63
Payment of, upon failure to deliver or store excess wheat 62
Producer subject to penalty 62
Rate of penalty 62
Refund of penalty 98
When due 62
Proclamations—
National acreage allotment 55
National marketing quota 53
Normal supply and total supply 57
Referendum results 64
Referendum—
Effect of results 64
Eligible voters 64
Notice of farm quota and allotment mailed prior to 95
Proclamation of results 64
When conducted 64
Regulations, issuance by Secretary 100
Reports and records 98
Data confidential 99
Review of farm quota and allotment, *see also* Review of farm marketing quota and acreage allotment 95
State acreage allotments 56
Apportionment to counties 56
Diverted acreage 19
Penalty 65

Wheat—Continued
Page
International wheat agreement 189
Land use 17
Loans. *See* Price support.
Marketing allocation:
Authority to facilitate transition 108
Conversion factors 108
Determination by Secretary 104
Legislative findings 103
Marketing certificates:
Assistance in purchase and sale 108
Ineligible producers 106
Issuance by Secretary 105
Marketing restrictions 107
National allocation percentage 104
Penalties 109
Reports and records 109
Transfer of certificates 107
Unused certificates:
CCC authorized to purchase 107
Old farm 56
Parity payments 39
Storage of 56
Wool:
Advertising and sales promotion programs 172
Congressional policy 170
Disposition in case of death, incompetency 171
Marketing year 172
Payments 170–171
Price support 171
Yield:
National average, cotton and wheat 34
Normal—
Corn 37
Cotton 37
Peanuts 35
Rice 36
Wheat 36

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Predicting

RAINFALL-EROSION LOSSES FROM CROPLAND EAST OF THE ROCKY MOUNTAINS

Guide for Selection of Practices for Soil and Water Conservation

AGRICULTURE HANDBOOK NO. 282

AGRICULTURAL RESEARCH SERVICE • U.S. DEPARTMENT OF AGRICULTURE
IN COOPERATION WITH PURDUE AGRICULTURAL EXPERIMENT STATION

CONTENTS

	Page
Purpose of handbook	1
History of soil-loss equations	1
Soil-loss tolerances	2
The soil-loss equation	3
The equation model	3
The rainfall factor (R)	3
The soil-erodibility factor (K)	4
Factors for slope length (L) and gradient (S)	8
The cropping-management factor (C)	10
The erosion-control practice factor (P)	36
Limitations	38
Field applications of the soil-loss equation	38
Predicting field soil loss	38
Determining alternative ways in which a particular tract of land may be used and treated to conserve or improve it	40
Estimating source sediment from watersheds	41
Summary	43
Literature cited	44
Appendix	45

LIST OF TABLES

	Page
TABLE 1.—Computed K values for soils on erosion-research stations	5
TABLE 2.—Ratio of soil loss from cropland to corresponding loss from continuous fallow	12
TABLE 3.—Suggestions for approximating soil-loss ratios for cropping and management combinations not listed in table 2	15
TABLE 4.—Approximations of soil-loss ratios for crop-stage periods and number of tillage operations with stubble mulching and summer fallowing in western Plains areas	16
TABLE 5.—Working table for derivation of C value for 4-year rotation in central Indiana	35
TABLE 6.—Practice factor values for contouring	36
TABLE 7.—Length limits for contouring	37
TABLE 8.—Strip widths recommended for contours	37
TABLE 9.—Maximum permissible C values ($T/RKLS$) for indicated gradient and slope length with straight and with contoured rows for soil type with K, T, and R values as listed	42
TABLE 10.—Partial list of C values for common rotations for a specific erosion-index distribution area	43
TABLE 11.—Observed range and 5-, 20-, and 50-percent probability value of erosion index at each of 181 key locations	45
TABLE 12.—Expected magnitudes of single-storm erosion-index values	46

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PREDICTING RAINFALL-EROSION LOSSES FROM CROPLAND EAST OF THE ROCKY MOUNTAINS

Guide for Selection of Practices for Soil and Water Conservation

By Walter H. Wischmeier and Dwight D. Smith, *Soil and Water Conservation Research Division, Agricultural Research Service*

PURPOSE OF HANDBOOK

Scientific farm planning for soil and water conservation requires knowledge of the relations between those factors that cause loss of soil and water and those that help to reduce such losses on cropland. Since 1930, controlled studies on field plots and small watersheds have supplied much valuable information regarding these complex factor interrelations. But the greatest possible benefits from such research efforts can be realized only when the findings are rapidly converted to sound practice on the numerous farms throughout the country. Specific guidelines are needed to help select the control practices best suited to the particular needs of each farm.

The soil-loss prediction procedure presented in this handbook provides such guidelines. It is a technique whereby all pertinent research information is methodically combined to provide design data for conservation plans.

The empirical soil-loss equation underlying this technique is applicable in any location where numerical values of the equation's factors are known or can be determined. Research has supplied information from which at least approximate values of these factors can be derived for any location in the major agricultural areas of the United States. Tables and charts make this information readily available for field use.

Research is continuing to obtain more complete and more precise information on the interrelations of topography, soil, and management practices. Additional knowledge gained can be readily brought into the present prediction procedure. Experience has shown, however, that the factor values reported herein are sufficiently accurate to provide very valuable guidelines for conservation farm planning and to aid in estimating gross erosion from watersheds.

The soil-loss equation in its present form is the result of more than 20 years of development and has had many contributors.

HISTORY OF SOIL-LOSS EQUATIONS

Development of equations for calculating field soil loss began about 1940 in the Corn Belt States. The soil-loss estimating procedure developed in that region between 1940 and 1956 has been generally referred to as the slope-practice method. Zingg (*28*) [1] published an equation in 1940 relating soil-loss rate to length and percentage of slope. In the following year, Smith (*12*) added crop and conservation-practice factors and the concept of a specified soil-loss limit, to develop a graphical method for determining conservation practices needed on the Shelby and associated soils of the Midwest. Browning and coworkers (*1*) added soil erodibility and management factors and prepared a set of tables to simplify field use of the equation in Iowa. Other advances and adaptations of the procedure in the Corn Belt were made by Smith and Whitt (*13, 14*) and by Van Doren and Bartelli (*19*). Research scientists and operations personnel in the North Central States worked together in developing the slope-practice method for use throughout the Corn Belt States.

In 1946, a nationwide committee on soil-loss prediction met in Ohio for the purpose of adapting the Corn Belt equation to other cropland areas with erosion problems. This committee reappraised the Corn Belt factor values and added a rainfall factor (*9*). The resulting formula, generally known as the Musgrave equation, has been widely used for estimating gross erosion from watersheds in flood abatement programs. A graphical solution of the equation was published in 1952 by Lloyd and Eley (*5*) and used by the Soil Conservation Service in the Northeastern States.

[1] Italic numbers in parentheses refer to Literature Cited, p. 44.

Years of field experience by the Soil Conservation Service in the Corn Belt and the Northeastern States proved the value of soil-loss prediction as a tool to help guide conservation farm planning. Extension of the usefulness of these equations to new areas was seriously hampered by the lack of procedures and basic information for adjusting measured factor values for differences in rainfall distribution, types of rainstorms expected, localized farming methods, length of growing season, and other variables.

An improved soil-loss equation developed in the latter part of the 1950's (*18*, *26*) overcame many of the limitations of the earlier equations. The improved equation was developed at the Runoff and Soil-Loss Data Center of the Agricultural Research Service, established at Purdue University in 1954. Most of the basic runoff and soil-loss data obtained in studies in the United States since 1930 were assembled at this location for summarization and further analyses.[2] These analyses resulted in several major improvements that were incorporated in the new soil-loss equation: (1) an improved rainfall-erosion index (*21*); (2) a method of evaluating cropping-management effects on the basis of local climatic conditions (*22*); (3) a quantitative soil-erodibility factor; and (4) a method of accounting for effects of interrelations of such variables as productivity level, crop sequence, and residue management.

These developments freed the equation from some of the generalizations and the geographic and climatic restrictions inherent in earlier models. Because of its general applicability, the improved equation presented in this handbook has been referred to in some of the literature as the "universal" soil-loss equation (*10*, *16*, *17*, *18*, *26*).

SOIL-LOSS TOLERANCES

The term "soil-loss tolerance" is used to denote the maximum rate of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely. This rate has usually been expressed in terms of average soil loss per acre per year. Knowledge of the expected rate of soil erosion for each of various alternative cropping systems and management plans on any particular field may be obtained by use of the erosion equation. When these predicted losses can be compared with a soil-loss tolerance for that field, very specific guidelines are provided for effecting erosion control within the specified limits. Any cropping and management combination for which the predicted erosion rate is less than the tolerance may be expected to provide satisfactory erosion control. From the various satisfactory alternatives indicated by the soil-loss prediction procedure, the farmer may then select the land use and management combination best suited to his particular farm enterprise.

Establishment of tolerances for specific soils and topography has been largely a matter of collective judgment. Both physical and economic factors are considered. For the soils in the United States, the maximum soil-loss rates thus determined range from 1 to 5 tons per acre per year, depending upon soil properties, soil depth, topography, and prior erosion. A deep, medium-textured, moderately permeable soil that has subsoil characteristics favorable for plant growth has a tolerance of 5 tons per acre. Tolerances for soils with a shallow root zone, or with a high percentage of shale at the surface, are usually quite low.

Soil-loss tolerances for the major soil types were subjectively evaluated at regional Soil-Loss Prediction Workshops, and lists were distributed in the workshop reports.[3]

[2] Data used to develop the present equation and supporting tables and charts were contributed by personnel on Federal-State cooperative research projects at the following locations: Batesville, Ark.; Tifton and Watkinsville, Ga.; Dixon Springs, Joliet, and Urbana, Ill.; Lafayette, Ind.; Clarinda, Castana, Beaconsfield, Independence, and Seymour, Iowa; Hays, Kans.; Baton Rouge, La.; Presque Isle, Maine; Benton Harbor and East Lansing, Mich.; Holly Springs and State College, Miss.; Bethany and McCredie, Mo.; Hastings, Nebr.; Beemerville, Marlboro, and New Brunswick, N.J.; Ithaca, Geneva, and Marcellus, N.Y.; Statesville and Raleigh, N.C.; Coshocton and Zanesville, Ohio; Cherokee and Guthrie, Okla.; State College, Pa.; Clemson and Spartanburg, S.C.; Knoxville and Greeneville, Tenn.; Temple and Tyler, Tex.; Blacksburg, Va.; Pullman, Wash.; LaCrosse, Madison, and Owen, Wis.; and Mayaguez, P.R. Rainfall data for development of the iso-erodent map and erosion-index distribution curves were supplied by the U.S. Weather Bureau, National Records Center.

[3] ARS-SCS Soil Loss Prediction Workshop Reports:
1959. Soil loss estimation in Tennessee. Knoxville, Tenn.
1960. Soil loss estimation in the Southeast. Athens, Ga.
1961. Soil loss prediction, North Dakota, Nebraska, and Kansas. Lincoln, Nebr.
1961. Soil loss prediction for Arkansas, Louisiana, Mississippi, Oklahoma, and Texas. Little Rock, Ark.
1962. Soil loss prediction for the North Central States. Chicago, Ill.
1962. Soil loss prediction for the Northeastern States. New York, N.Y.

These reports are mimeographed, but may be available either from the Agricultural Research Service or the Soil Conservation Service.

THE SOIL-LOSS EQUATION

The Equation Model

The soil-loss equation is

$$A = R\ K\ L\ S\ C\ P$$

where A is the computed soil loss per unit area.

R, the rainfall factor, is the number of erosion-index units in a normal year's rain. The erosion index is a measure of the erosive force of specific rainfall.

K, the soil-erodibility factor, is the erosion rate per unit of erosion index for a specific soil in cultivated continuous fallow, on a 9-percent slope 72.6 feet long. The reasons for selection of these conditions as unit values is explained in the detailed discussion of this factor.

L, the slope-length factor, is the ratio of soil loss from the field slope length to that from a 72.6-foot length on the same soil type and gradient.

S, the slope-gradient factor, is the ratio of soil loss from the field gradient to that from a 9-percent slope.

C, the cropping-management factor, is the ratio of soil loss from a field with specified cropping and management to that from the fallow condition on which the factor K is evaluated.

P, the erosion-control practice factor, is the ratio of soil loss with contouring, stripcropping, or terracing to that with straight-row farming, up-and-down slope.

Numerical values for each of the six factors ave been determined from research data. These alues differ from one field or locality to another. he approximate numerical values for any parıcular field may be obtained from the figures nd tables presented herein.

The subsection entitled "Predicting Field Soil oss," page 38, illustrates how to select appropriate values from the figures and tables. The eader who has had no prior experience with the il-loss equation may wish first to read that ction. After he has referred to the tables and gures and located the values used in the example, e will be able to understand the intervening etailed discussions of the equation's factors.

In actual practice, the equation is usually not lved in selecting practices for each farm field. many locations, persons experienced in the use the equation have prepared reference tables at provide the information needed for the ecific locality.

The soil-loss prediction procedure can be more telligently used as a guide for selection of prac-es if the user has a general knowledge of the inciples and factor interrelations on which the uation is based. Therefore, the significance of ch factor is discussed before presenting the ready-reference table or chart from which locational values of that factor may be obtained. Limitations of the data available for evaluation of some of the factors are also pointed out.

The Rainfall Factor (R)

One major difference between the universal soil-loss equation and its predecessors is in the manner and precision with which locational differences in rainfall are brought into the soil-loss computations. The Corn Belt slope-practice equation was based on an overall average of the severity and distribution of the rainfall that occurred on the plot studies in that region. This average rainfall effect was reflected in an 8-ton base soil-loss rate for a 3-year rotation of corn, oats, and meadow. The Musgrave equation assumed that the erosivity of annual rainfall varied as the 1.75 power of the 2-year maximum 30-minute rainfall. This relation was based on limited data taken in Wisconsin in the 1930's. Research since 1946 has not supported the accuracy of this term as an indicator of annual rainfall erosivity. Furthermore, its use as a rainfall factor allowed no consideration of effects of locational differences in the number of erosive rainstorms and in their expected distribution within the year.

Rills and sediment deposits observed after an unusually intense storm could lead to the conclusion that the significant soil erosion is associated with only a few rare storms. However, more than 30 years of measurements in many States have shown that such is not the case (*24*). The data showed that a rainfall factor used to estimate average annual soil loss must include the cumulative effects of the many moderate-size storms, as well as the effects of the occasional very severe ones.

The rainfall factor in the soil-loss equation is the rainfall erosion index reported by Wischmeier in 1959 (*21*). Locational values of this factor were published in 1962 in the form of an iso-erodent map (*23*).

The Rainfall Erosion Index

Exploratory analyses of the large volume of soil loss and rainfall data assembled at the Runoff and Soil Loss Data Center brought out a very helpful relation between soil loss and a single rainstorm parameter. The research data show that when factors other than rainfall are held constant, storm soil losses from cultivated fields are directly proportional to the product value of two rainstorm characteristics: total kinetic energy of the storm times its maximum 30-minute intensity (EI). This product variate is an interaction term that reflects the combined potential

of raindrop impact and turbulence of runoff to transport dislodged soil particles from the field. The value of this statistic for any particular rainstorm can be computed from a recording-raingage record with the help of a rainfall energy table published in 1958 (*25*).

The sum of the computed storm *EI* values for a given time period is a numerical measure of the erosivity of all the rainfall within that period. The rainfall erosion index at a particular location is the longtime-average yearly total of the storm *EI* values. The storm *EI* values reflect the interrelations of significant rainstorm characteristics. Summing these values to compute the erosion index adds the effect of frequency of erosive storms within the year.

Iso-Erodent Map

Locational values of the rainfall factor, *R*, may be taken directly from the iso-erodent map reproduced in figure 1. The lines joining points with the same erosion-index value (which implies equally erosive average annual rainfall) are called iso-erodents. The average number of erosion-index units per year along each iso-erodent is the value of *R* in the erosion equation. Points lying between the indicated iso-erodents may be approximated by linear interpolation.

To develop the map, the locational value of the erosion index was computed from rainfall data for each of about 2,000 locations fairly evenly distributed over the 37 States. The iso-erodents were then plotted as indicated by these values (*23*).

Iso-erodents in the mountainous States west of the 104th meridian were not included because of the sporadic rainfall pattern of the mountains. In this area, one weather station may average fewer than 10 inches of rain per year, whereas another station less than 100 miles away averages more than 25 inches. Locational erosion-index values are probably equally sporadic, but are not directly proportional to rain amounts. A very large number of locational rain-intensity records would be required to establish iso-erodents in the mountainous States. In the scattered agricultural areas where rainfall is sufficient to pose an erosion hazard, locational values of the erosion index can be computed from rainfall records within those specific areas, but a few spot values of the index should not be considered representative of a large geographic area.

The iso-erodent map shows that erosion-index values in the 37 States range from 50 to 600. The erosion index measures only the effect of rainfall when separated from all other factors that influence erosion. If the soil and topography were exactly the same everywhere, average annual soil losses from plots maintained in continuous fallow would differ in direct proportion to the erosion-index values. This potential difference is, however, partially offset by differences in soil, topography, vegetal cover, and residues. On fertile soils in the high rainfall areas of the Southern States, good vegetal cover protects the soil surface throughout most of the year and heavy plant residues may provide excellent cover also during the dormant season. In the regions where the erosion index is extremely low, rainfall is seldom adequate for establishment of meadows and good cover provided by other crops is often limited to only a relatively short period. Hence, serious soil-erosion hazards exist in semiarid regions as well as in humid.

In areas such as the Pacific Northwest, where snowmelt causes a large part of the field erosion, the practical value of the rainfall-erosion equation in its present form has not been established.

Probability Values of the Erosion Index

When the erosion equation is used to estimate average annual soil loss, the value of the factor *R* must equal the *average annual* value of the erosion index at that location as obtained from the iso-erodent map. If desired, however, some specific probability value of the erosion index, other than annual averages, may be substituted for *R* in the equation. For example, the quantity of soil loss that will be exceeded 1 year in 5, on the average, may be estimated by assigning to *R* the 20-percent probability of the erosion index.

The 50-percent, 20-percent, and 5-percent probability values of the index at 181 key locations are shown in appendix table 11.

To approximate the amount of soil loss from a single storm that will probably be exceeded once in 1, 2, 5, 10, or 20 years, the factor *R* may be assigned a value selected from appendix table 12. For this purpose, however, the value of *C* should be determined as indicated under "Individual-Storm Soil Losses."

The Soil-Erodibility Factor (*K*)

The meaning of the term "soil erodibility" is distinctly different from that of the term "soil erosion." The rate of soil erosion on any area may be influenced more by land slope, rainstorm characteristics, cover, and management than by properties of the soil itself. The total rate of soil loss is designated by the symbol *A* in the equation. But some soils erode more readily than others even when slope, rainfall, cover, and management are the same. This difference, due to properties of the soil itself, is referred to as the soil erodibility.

Soil properties that influence erodibility by water are (1) those that affect the infiltration rate, permeability, and total water capacity, and (2) those that resist the dispersion, splashing, abrasion, and transporting forces of the rainfall and runoff. A number of attempts have been made to determine criteria for scientific class-

ification of soils according to erodibility (*4, 6, 7, 11, 16*). Generally, however, soil classifications used for erosion prediction have been largely subjective and have been only relative rankings.

The relative erodibility of different soils is difficult to judge from field observations. Even a soil with a relatively low erodibility factor may show signs of serious erosion when the soil occurs on long or steep slopes or in localities having numerous high-intensity rainstorms. A soil with a high natural erodibility factor, on the other hand, may show little evidence of actual erosion under gentle rainfall when it occurs on short and gentle slopes or when the best possible management is practiced. The effects of rainfall differences, slope, cover, and management are accounted for in the prediction equation by the symbols R, L, S, C, and P. Therefore, the soil-erodibility factor, K, must be evaluated independently of the effects of the other factors.

Definition of the Factor *K*

The soil-erodibility factor, K, in the soil-loss equation is a quantitative value, experimentally determined. For a particular soil, it is the rate of erosion per unit of erosion index from *unit* plots on that soil.

A *unit* plot is 72.6 feet long, with a uniform lengthwise slope of 9 percent, in continuous fallow, tilled up and down the slope. Continuous fallow, for this purpose, is land that has been tilled and kept free of vegetation for a period of at least 2 years or until prior crop residues have decomposed. During the period of soil-loss measurements, the plot is plowed and placed in conventional corn seedbed condition each spring and is tilled as needed to prevent vegetal growth or serious surface crusting. When all of these conditions are met, each of the factors L, S, C, and P has a value of 1.0 and K equals A/EI.

The conditions listed above were selected as unit values in the soil-loss equation because they represent the predominant slope length and the median gradient on which past erosion measurements in the United States have been made, and the designated management provides the surface condition least influenced by differences in climate and local cropping systems.

Direct measurements of K on well replicated unit plots as described should reflect the combined effects of all the variables that significantly influence the ease with which a soil is eroded by rainfall and runoff. To evaluate K for soils that do not usually occur on a 9-percent slope, soil-loss data from plots that meet all the other specified conditions are adjusted to 9-percent slope by means of the slope factor.

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Values of *K*

Values of K determined for 23 major soils on which erosion plot studies were conducted since 1930 are listed in table 1. Seven of these values are from continuous fallow. The others are from row crops averaging 20 plot-years of record per location and requiring a minimum of adjustment for management effects (*10*).

TABLE 1.—*Computed K values for soils on erosion-research stations*

Soil	Source of data	Computed K
Dunkirk silt loam	Geneva, N.Y.	[1] 0.69
Keene silt loam	Zanesville, Ohio	.48
Shelby loam	Bethany, Mo.	.41
Lodi loam	Blacksburg, Va.	.39
Fayette silt loam	LaCrosse, Wis.	[1] .38
Cecil sandy clay loam	Watkinsville, Ga.	.36
Marshall silt loam	Clarinda, Iowa	.33
Ida silt loam	Castana, Iowa	.33
Mansic clay loam	Hays, Kans.	.32
Hagerstown silty clay loam	State College, Pa.	[1] .31
Austin clay	Temple, Tex.	.29
Mexico silt loam	McCredie, Mo.	.28
Honeoye silt loam	Marcellus, N.Y.	[1] .28
Cecil sandy loam	Clemson, S.C.	[1] .28
Ontario loam	Geneva, N.Y.	[1] .27
Cecil clay loam	Watkinsville, Ga.	.26
Boswell fine sandy loam	Tyler, Tex.	.25
Cecil sandy loam	Watkinsville, Ga.	.23
Zaneis fine sandy loam	Guthrie, Okla.	.22
Tifton loamy sand	Tifton, Ga.	.10
Freehold loamy sand	Marlboro, N.J.	.08
Bath flaggy silt loam with surface stones >2 inches removed.	Arnot, N.Y.	[1] .05
Albia gravelly loam	Beemerville, N.J.	.03

[1] Evaluated from continuous fallow. All others were computed from row-crop data.

Other soils on which valuable erosion studies have been conducted (see footnote 2, p. 2) were not included in the table because of uncertainties involved in adjustments of the data for effects of cropping and management. Short periods of record from plots cropped to rotations that provide good canopy or residue protection most of the time cannot presently serve for authentic evaluation of K, even though the studies were well designed and provided valuable data for evaluation of other factors in the equation.

Soil-erodibility values for numerous other soils have been approximated by considering a soil's characteristics and tempering the estimate of its erodibility against the established values for the 23 soils listed in table 1. Such estimated values for all the major soils in the several major geographic regions were prepared at joint ARS–SCS Regional Soil-Loss Prediction Workshops.[4]

[4] See footnote 3, p. 2.

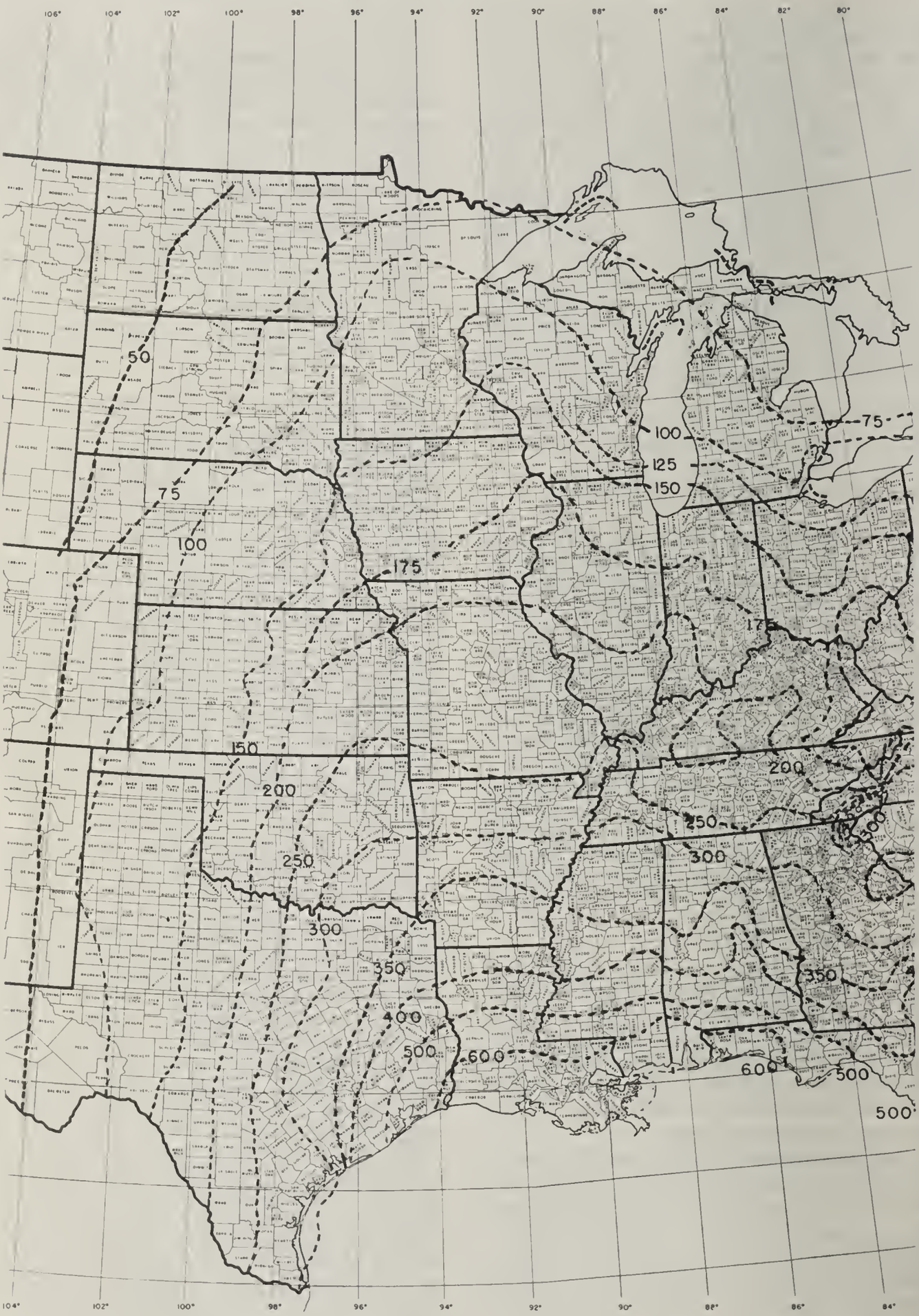
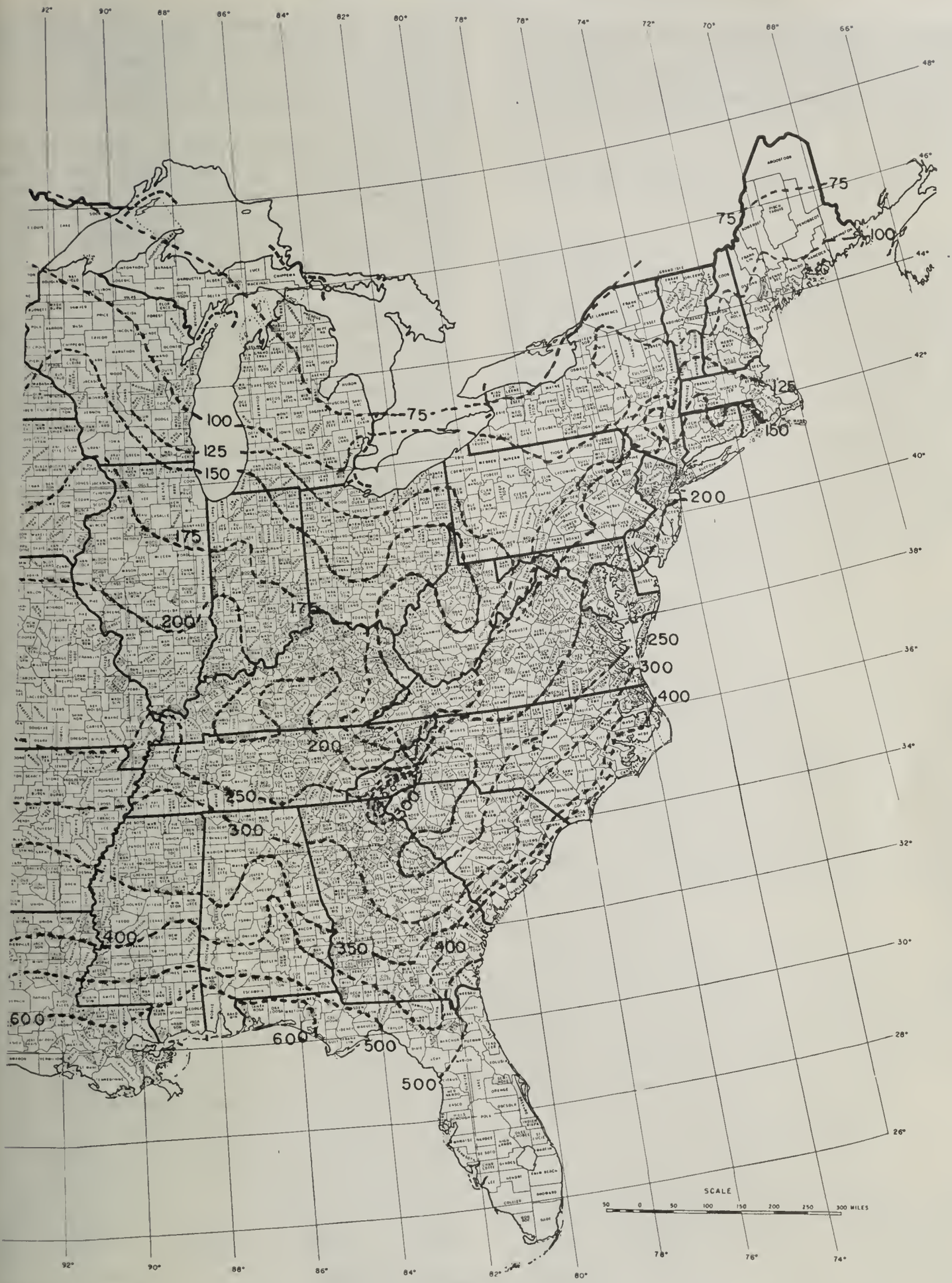


FIGURE 1.—Average annual



lues of the rainfall factor, *R*.

Increased research efforts, begun in 1961 at several locations, are designed to identify and evaluate the various soil properties that influence erodibility. Additional benchmark values are also being obtained by direct measurement of K on unit plots.

Factors for Slope Length (L) and Gradient (S)

The rate of soil erosion by water is very much affected by both slope length and gradient (percent slope). The two effects have been evaluated separately in research and are represented in the erosion equation by L and S, respectively. In field application of the equation, however, it is convenient to consider the two as a single topographic factor, LS.

The Slope-Effect Chart

The factor LS is the expected ratio of soil loss per unit area on a field slope to corresponding loss from the basic 9-percent slope, 72.6 feet long. This ratio, for specific combinations of slope length and gradient, may usually be taken directly from the slope-effect chart (fig. 2). For example, a 10-percent slope, 360 feet long, would have an LS ratio of 2.6.

When the equation is used as a guide for selection of practices on an area where several slopes are combined into a single field, the slope characteristics of the most erosive significant segment of the field should be used for figure 2. Use of field averages on such slope complexes would underestimate soil movement on significant parts of the field.

The slope-effect chart assumes essentially uniform slopes. Field slopes are often either convex (steepening substantially toward the lower end) or concave (flattening toward the lower end). The effect of convexity or concavity of slopes on soil-erosion rates has not been fully evaluated. However, limited data indicate that use of the *average* gradient of the entire slope length would substantially underestimate soil loss from the con-

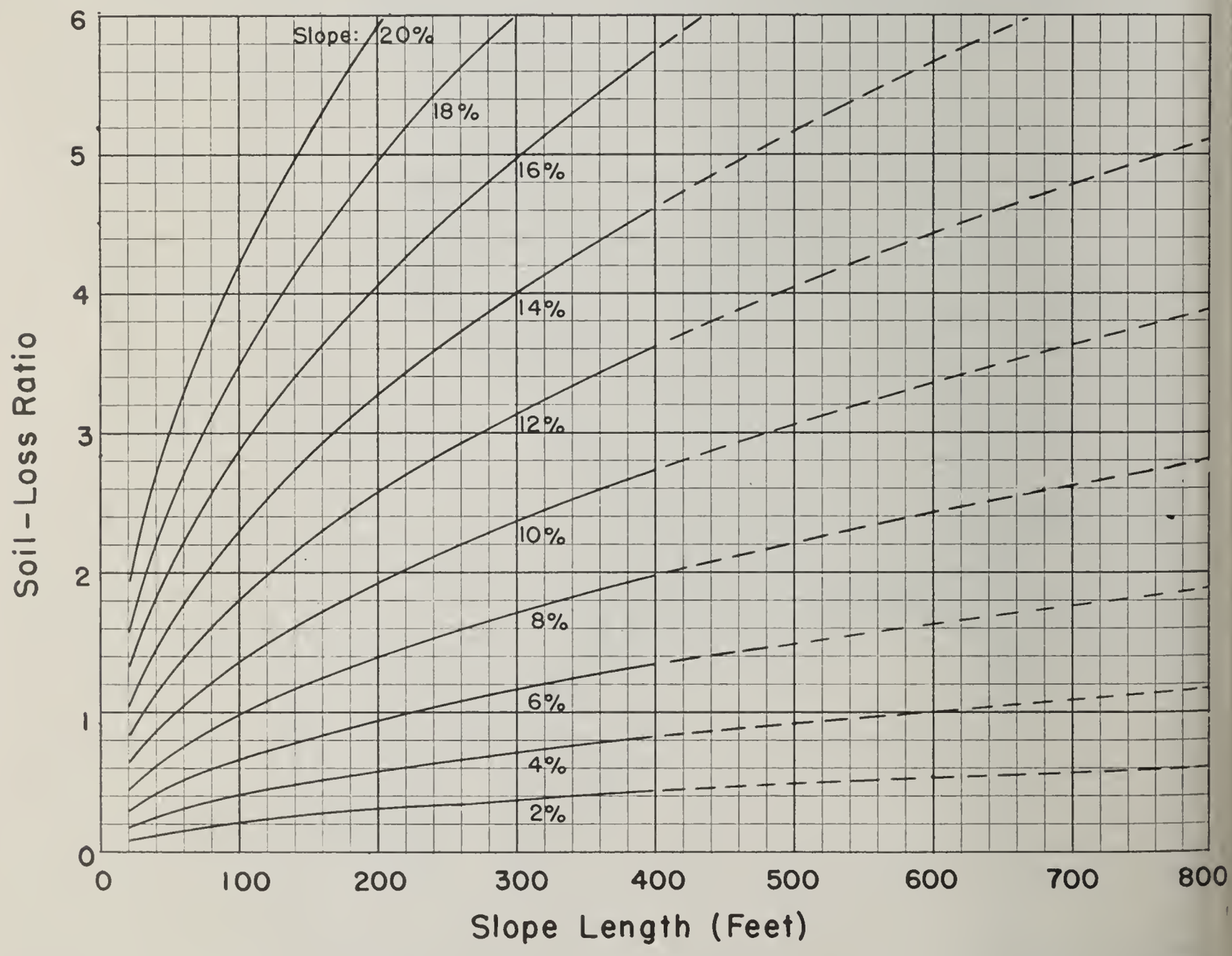


FIGURE 2.—Slope-effect chart (topographic factor, LS).

vex slopes and would overestimate the loss from concave slopes. When the lower end of the slope is steeper than the upper end, the gradient of the steeper segment should be used with the overall slope length to enter the slope-effect chart. On a concave slope, deposition may occur on the lower end of the field. In such cases, the appropriate length and gradient are those of that segment of the slope that is above the point where it flattens enough for deposition to occur.

The broken-line portions of the curves on the chart were extrapolated to provide the best estimates now available for slopes longer than those measured in plot studies. Subsequent investigations on slopes longer than 300 feet may show need for revision of these segments of the curves.

Values of LS for slope percentages not shown on the chart may be computed by solving the following equation:

$$LS=\sqrt{\lambda}(0.0076+0.0053s+0.00076s^2)$$

where λ is the field slope length in feet, and s is the gradient expressed as slope percent.

Slope Length

Slope length is defined as the distance from the point of origin of overland flow to either of the following, whichever is limiting for the major part of the area under consideration: (1) the point where the slope decreases to the extent that deposition begins or (2) the point where runoff enters a well-defined channel that may be part of a drainage network or a constructed channel such as a terrace or diversion (*15*).

Numerous plot studies have shown that the soil loss per unit area is proportional to some power of slope length. Since the factor L is the ratio of field soil loss to that from a 72.6-foot slope, the value of L may be expressed as $\left(\frac{\lambda}{72.6}\right)^m$, where λ is field slope length in feet and the exponent m is determined from field data. The magnitude of the exponent m in this expression is not the same for all locations or for all conditions at a given location (*27*). Its average value in past investigations under natural rainfall has been about 0.5. This is the value used for development of the slope-effect chart (fig. 2).

The value of m is significantly influenced by the interaction of slope length with gradient and may also be influenced by soil properties, type of vegetation, and management practices. On slopes steeper than 10 percent, a value of 0.6 for m is recommended. A value of 0.3 appears applicable to the very long slopes of less than one-half percent gradient encountered in the furrow-irrigated sections of the High Plains of western Texas. Data from gently sloping Houston clay and Mansic clay loam soils that were frequently dry and deeply cracked showed a decrease in runoff with increased slope length and indicated a value of $m=0.3$ for these particular soils. Other than for these special cases, use of the 0.5-power relation reflected in figure 2 is presently recommended. However, further research investigation may soon provide a basis for recommending other deviations from this overall average.

Figure 3 provides a graphical method for determining the value of LS when conditions indicate that a length exponent other than 0.5 is applicable. For example, assume a 600-foot slope length on Houston clay with 4-percent gradient and an exponent of 0.3. Entering figure 2 with the 260 found in figure 3, the LS value for the assumed situation is about 0.68. A 600-foot slope length under conditions where the applicable exponent is 0.4 is shown to be equivalent to a 390-foot length under conditions where the exponent is 0.5.

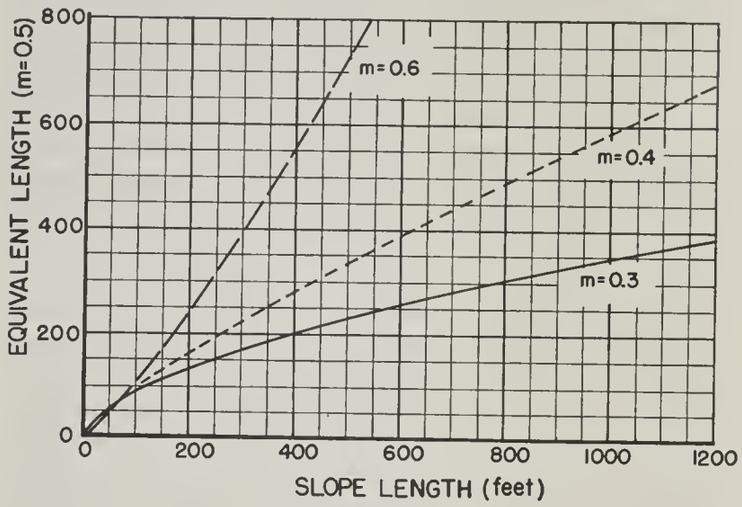


FIGURE 3.—Equivalent slope lengths for use of slope-effect chart when the value of the pertinent length-exponent is not 0.5.

Slope Gradient

A. W. Zingg, in 1940, concluded that soil loss varies as the 1.4 power of percent slope (*28*). In 1946, the Musgrave Committee (*9*) recommended use of the 1.35 power of percent slope. Based on analyses of the data assembled at the Runoff and Soil-Loss Data Center Smith and Wischmeier (*15*) in 1957 proposed the relation:

$$S=\frac{0.43+0.30s+0.043s^2}{6.613}$$

where s is the gradient expressed as percent slope and S is the slope factor in the erosion equation. The latter relation was used to derive figure 2.

The relation of soil loss to gradient is influenced by density of vegetal cover and by soil particle size. However, research data are presently not adequate to determine the specific conditions

under which deviations from the expressed average relation would be significant.

The Cropping-Management Factor (*C*)

The effects of cropping and management variables cannot be evaluated independently because of the many interre ations involved. Almost any crop can be grown continuously, or it can be grown in any one of numerous rotations. The sequences of crops within a system can be varied. Crop residues can be removed, left on the surface, incorporated near the surface, or plowed under. When left on the surface, they can be chopped or they can be allowed to remain as left by the harvesting operation. Seedbeds can be left rough, with much available capacity for surface storage of rainfall, or they can be left smooth. Different combinations of these variables are likely to have different effects on soil loss.

In addition, the effectiveness of crop-residue management will depend on how much residue there is. This, in turn, depends on rainfall distribution, on the fertility level, and on various management decisions made by the farmer. Similarly, the erosion-control effectiveness of meadow sod turned under before corn or other rowcrops depends on the type and quality of the meadow and on the length of time elapsed since the sod was turned under.

The canopy protection of crops not only depends on the type of vegetation, the stand, and the quality of growth, but it also varies greatly in different months or seasons. Therefore, the overall erosion-reducing effectiveness of a crop depends largely on how much of the erosive rain occurs during those periods when the crop or management practice provides the least protection.

Definition of Factor *C*

The factor *C* in the soil-loss equation is the ratio of soil loss from land cropped under specified conditions to the corresponding loss from tilled, continuous fallow. This factor measures the combined effect of all the interrelated cover and management variables listed in the preceding three paragraphs.

The loss that would occur on a particular field if it were continuously in fallow condition is computed by the four-factor product, *RKLS*, in the erosion equation. Actual loss from the cropped field is usually much less than this amount. Just how much less depends on the particular combination of cover, crop sequence, and management practices. It also depends on the particular stage of growth and development of the vegetal cover at the time of the rain. The factor *C* adjusts the soil-loss estimate to suit these conditions.

The correspondence of periods of expected highly erosive rainfall with periods of poor or good plant cover differs between regions or locations. Therefore, the value of *C* for a particular cropping system will not be the same in all parts of the country. In order to derive the appropriate *C* values for a given locality, it is necessary to know how the erosive rainfall in that locality is likely to be distributed through the 12 months of the year. It is also necessary to know how much erosion-control protection the growing plants, the prior-crop residues, and various tillage operations will provide at the time when erosive rains are likely to occur. A procedure has been developed for deriving locational values of the factor *C* on the basis of available weather records and research data that reflect effects of crops and management. The cropping and weather data needed for this purpose appear in ready-reference form in the subsections entitled "Soil-Loss Ratios" and "Erosion-Index Distribution Curves."

The change in effectiveness of plant cover within the crop year is gradual. For practical purposes, it was necessary to divide the year into a series of crop stage periods so defined that cover and management effects may be considered approximately uniform within each period.

Crop Stage Periods

The five crop stage periods that are used for computation of locational *C* values are defined as follows:

Period F.—*Rough fallow.* Turn plowing to seeding.

Period 1.—*Seedling.* Seedbed preparation to 1 month after planting.

Period 2.—*Establishment.* From 1 to 2 months after spring or summer seeding. For fall-seeded grain, period 2 includes the winter months, ending about May 1 in the Northern States, April 15 in the Central States, and April 1 in the Southern States.

Period 3.—*Growing and maturing crop.* End of period 2 to crop harvest.

Period 4.—*Residue or stubble.* Crop harvest to plowing or new seeding. (When meadow was established in small grain, grain period 4 was assumed to extend 2 months beyond the grain harvest date. After that time, the vegetation was classified as established meadow.)

Some adjustment in length of periods 1 through 3 may be necessary for vegetable crops.

Effects of Cropping System and Management on Soil Loss

About 10,000 plot-years of runoff and soil-loss data assembled from 47 research stations in 24 States (*20*) were analyzed to obtain empirical measurements of the effects of cropping system and management on soil loss within each crop-stage period. Several significant factor relations that became apparent from the analyses provide

background information for interpretation of the soil-loss ratio table.

Erosion From Fallow Soil.—The rate at which fallow soil eroded depended on cropping history and the nature and quantity of residues turned under as well as on inherent characteristics of the soil itself. Brief periods of fallow in a rotation were not comparable in erodibility to continuous clean-tilled fallow on similar soil and slope. Plant residues incorporated in fallow soil were very effective in reducing both runoff and erosion. Effects of cropping history are a part of the factor *C* in the erosion equation.

Productivity Level and Soil Loss.—In general, soil losses decreased as crop yields increased. Since good grain yields are usually associated with good stands and good forage growth, the canopy cover is better and more residues are returned to the soil. Both help to decrease erosion losses. However, the added erosion-reducing benefit of each additional unit of crop yield becomes less as yields become higher.

Crop-Residue Management.—The soil-loss reduction resulting from prior crop residues left on the field depended on the type and quantity of residues produced and the method of handling. Residues were most effective when left at the surface. But after several years of turning heavy crop residues under with a moldboard plow before row-crop seeding, both runoff and soil loss from the row crop were much less than from similar plots from which cornstalks and grain straw were removed at harvesttime. The effectiveness of incorporated residues was greatest during the fallow and seedling periods.

Erosion From Row Crop After Meadow.—Specific-year erosion losses from corn after meadow ranged from 14 to 68 percent of corresponding losses from continuous corn on adjacent plots. Mixtures of grass and legume were more effective than legumes alone. In general, the effectiveness of grass-and-legume meadow sod plowed under before corn in reducing soil loss from the corn was directly proportional to meadow yields. Its erosion-control effectiveness was greatest during the fallow and corn-seedling periods and decreased as the corn year moved along. The total reduction in soil loss effected by the meadow depended, therefore, largely upon the stage of development of the corn when the erosive rains occurred. The length of the period during which the turned sod remained effective in reducing erosion was also directly related to meadow yields.

Effect of Length of Meadow Periods.—Direct comparisons of corn after first, second, and third years of meadow were very limited, and the data were too sporadic for overall differences to be statistically significant. When second-year meadow was allowed to deteriorate under poor management, it was less effective than 1 year of meadow. When succeeding meadows were more productive than first-year, they were usually more effective in reducing erosion from corn after the meadow. The effectiveness of virgin sod and of long periods of continuous alfalfa in which grass became well established was longer lasting than that of 1 or 2 years of rotation meadow.

Grass-and-legume catch crops established in spring-seeded small grain and plowed under at corn planting time in the following year effected significant reduction in soil erosion during the corn seedling period, but their effectiveness was shorter lived than that of a full year of meadow.

Winter-Cover Seedings.—The erosion control attained with winter-cover seedings depended upon time and method of seeding, time of plowing, rainfall distribution, and type of cover seeded. Covers such as vetch and ryegrass seeded between the corn or cotton rows before harvest and turned under in April were effective in reducing erosion not only in the winter months but also during the seedling and establishment periods of the following crop. Small grain alone seeded in corn or cotton residues and plowed under in spring was of some value during the winter period but showed no residual erosion-reducing effect after the next year's corn or cotton planting. Very limited data indicated crimson clover alone to be of doubtful value as a winter cover, but when it was combined with a quick-starting grass, effective protection was provided. Small grain or vetch seeded in the fall on plowed cottonland and turned under in spring for another cotton seeding lost about 20 percent more soil than adjacent plots with undisturbed cotton residues on the surface.

Soil-Loss Ratios

Humid Areas.—An empirical measure of the erosion-control effectiveness of each crop, grown in various sequences, was obtained from the assembled plot data. Ratios of soil losses from the cropped plots to corresponding losses from continuous fallow were computed. This ratio was computed for each of the five crop-stage periods previously defined, for each particular crop, in various combinations of crop sequence and productivity level.

A 10-column, 100-line table of the computed soil-loss ratios was published in 1960 by Wischmeier (*22*). This table was not as comprehensive as would be desirable from an application viewpoint. Some combinations of conditions encountered in field soil-loss estimation in various parts of the United States were omitted from the table, because not enough research data were available to make sound evaluations of these particular combinations. Nevertheless, the table was comprehensive enough to test the validity and value of the new procedure for deriving rotation *C* values on a locational basis. It also provided

a broad set of benchmark values from which other ratios could be estimated by subjective comparisons.

Table 2 is an expansion of the previous'y published soil-loss ratio table. It lists, for each crop-stage period, the expected ratio of soil loss from the designated crop and practice combination to corresponding loss from the base fallow condition. The table is entered on the basis of crop, crop sequence, residue management, and crop productivity level, in that order. The soil-loss ratio for each crop-stage period is taken from the seven columns at the right. Three columns are needed for corn-period 4, in order to reflect effects of different ways of managing the field during that period. Suggestions for estimating soil-loss ratios under some of the conditions not directly listed in this table are shown in table 3.

TABLE 2.—*Ratio of soil loss from cropland to corresponding loss from continuous fallow*

Line No.	Cover, sequence, and management [1]	Productivity [2]		Soil-loss ratio for crop-stage period [3]						
		Hay yield	Corn yield	F	1	2	3 [4]	4L	4R	4L+WC
	CORN IN ROTATION									
	1st-year C after gr & lg hay:	*Tons*	*Bu.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
1	Spg TP, conv till	3–5	75+	8	25	17	10	15	35	10
2	Do	2–3	75+	10	28	19	12	18	40	11
3	Do	2–3	60–74	12	29	23	14	20	43	13
4	Do	1–2	60–74	15	30	27	15	22	45	13
5	Do	1–2	40–59	15	32	30	19	30	50	15
6	Do	<1	40–59	23	40	38	25	35	60	18
7	Do	<1	20–35	23	40	43	30	45	65	23
8	Spg TP, min till	3–5	75+	------	8	8	6	15	35	10
9	Do	2–3	75+	------	10	10	7	18	40	10
10	Do	2–3	60–74	------	12	12	8	20	43	13
11	Do	1–2	60–74	------	15	15	9	22	45	13
12	Do	1–2	40–59	------	15	15	11	30	50	15
	2d-year C after gr & lg hay:									
13	RdL, spg TP, conv till	3–5	75+	25	48	37	20	24	------	14
14	Do	2–3	75+	32	51	41	22	26	------	15
15	Do	2–3	60–74	35	54	45	24	28	------	15
16	Do	1–2	40–59	42	57	49	28	42	------	21
17	Do	<1	40–59	46	62	54	30	50	------	25
18	Do	<1	20–35	55	66	60	35	65	------	33
19	RdL, spg TP, min till	3–5	75+	------	25	25	12	24	60	14
20	Do	2–3	75+	------	32	32	13	26	60	15
21	Do	2–3	60–74	------	35	35	14	28	65	15
22	Do	1–2	40–59	------	42	42	17	42	70	21
23	Do	<1	40–59	------	46	46	18	50	75	25
24	RdL, WC in prec C, conv till	3–5	75+	18	35	30	20	24	60	14
25	Do	2–3	75+	20	37	33	22	26	60	15
26	Do	2–3	60–74	21	39	36	24	28	65	15
27	Do	1–2	40–59	25	42	40	28	42	70	21
28	Do	<1	40–59	28	45	44	30	50	75	25
29	Do	<1	20–35	33	48	49	35	65	80	33
30	RdR, WC in prec C, conv till	3–5	75+	30	52	40	22	------	60	35
31	Do	2–3	60–74	35	55	45	24	------	65	35
32	Do	1–2	40–59	42	60	53	30	------	75	38
33	RdR, no WC, conv till	3–5	75+	55	62	47	22	------	60	--------
34	Do	2–3	60–74	60	65	51	24	------	65	--------
35	Do	1–2	40–59	65	72	57	30	------	70	--------
	3d or 4th year C after gr & lg hay, or 2d-year C after SG, red cl, or sw cl:									
36	RdL, conv till	3–5	75+	36	63	50	26	30	------	--------
37	Do	2–3	60–74	45	66	54	29	40	------	--------
38	Do	1–2	40–59	55	70	58	32	50	------	--------
39	Do	<1	20–35	70	76	64	38	65	------	--------
40	RdL, min till	3–5	75+	------	36	36	16	30	------	--------
41	Do	2–3	60–74	------	45	45	17	40	------	--------
42	Do	1–2	40–59	------	55	55	19	50	------	--------
43	RdL + WC in prec C	3–5	75+	22	46	41	26	30	------	18
44	Do	2–3	60–74	26	48	44	29	40	------	20
45	Do	1–2	40–59	33	51	47	32	50	------	25

See footnotes at end of table.

TABLE 2.—*Ratio of soil loss from cropland to corresponding loss from continuous fallow*—Continued

Line No.	Cover, sequence, and management [1]	Productivity [2]		Soil-loss ratio for crop-stage period [3]						
		Hay yield	Corn yield	F	1	2	3 [4]	4L	4R	4L+WC
	CORN IN ROTATION—continued									
46	RdL+WC in prec C	*Tons* <1	*Bu.* 20–35	*Pct.* 42	*Pct.* 56	*Pct.* 52	*Pct.* 38	*Pct.* 65	------	*Pct.* 33
47	RdR, conv till	3–5	75+	70	78	54	27	------	62	--------
48	Do	2–3	60–74	75	80	60	30	------	70	--------
49	Do	1–2	40–59	75	80	70	35	------	75	--------
50	RdR, 8 tons manure added	--------	60–74	60	70	52	28	------	62	--------
51	1st-year C after cl hay	2	40–55	21	35	32	25	35	60	--------
52	1st-year C after sw cl	---	40–55	23	45	38	28	35	60	--------
53	1st-year C after lesp hay	1–2	60–70	55	70	55	30	40	65	--------
54	Do	1–2	40–55	55	70	60	32	50	75	--------
55	C after 1 year cot after gr & lg hay	2–3	60–70	30	58	46	24	28	65	--------
56	Do	1–2	40–59	35	65	54	29	42	70	--------
	Corn in meadowless systems:									
57	After SG wintercrop, spg TP	--------	75+	22	37	35	22	27	------	--------
58	Do	--------	60–70	25	40	38	24	30	------	--------
59	Do	--------	40–55	30	45	42	30	40	------	--------
60	After SG, no intercrop, RdL	--------	--------	(5)	(5)	(5)	(5)	(5)	------	--------
	COTTON IN ROTATION									
61	1st-year cot after gr & lg hay	3–5	HP	8	25	30	20	22	------	15
62	Do	2–3	HP	10	30	35	25	25	------	16
63	Do	1–2	HP	15	34	40	30	30	------	18
64	Do	1–2	MP	15	34	45	35	33	------	20
65	Do	<1	MP	23	40	54	45	42	------	23
	2d-year cot after gr & lg hay:									
66	RdL, no WC seeding	3–5	HP	30	54	56	38	38	------	20
67	Do	2–3	HP	34	58	62	44	40	------	20
68	Do	1–2	MP	40	65	68	46	42	------	22
69	Do	<1	MP	45	70	70	50	48	------	25
70	RdL+WC in prec cot	3–5	HP	20	40	46	38	38	------	20
71	Do	2–3	HP	23	42	50	44	40	------	20
72	Do	1–2	MP	23	47	55	46	42	------	22
73	Do	<1	MP	27	51	57	50	48	------	25
	Cot after cot, 3d or more year after M:									
74	RdL, no WC seeding	--------	HP	42	70	70	48	42	------	22
75	Do	--------	MP	45	80	80	52	48	------	25
76	RdL+WC in prec cot	--------	HP	32	51	57	48	42	------	22
77	Do	--------	MP	35	58	65	52	48	------	25
78	Cot after 1 year C (RdL) after M	3–5	75+	25	48	49	32	38	------	20
79	Do	2–3	60–75	32	51	51	35	40	------	20
80	Do	1–2	40–59	35	54	56	38	45	------	23
81	Cot after 1 year C, C RdR	2–3	40–59	60	65	63	40	48	------	25
82	Cot after 2 years C (RdL) after M	3–5	75+	36	63	62	39	45	------	23
83	Do	2–3	60–75	45	66	68	45	48	------	25
84	Do	1–2	40–59	55	70	73	50	48	------	25
85	Cot in cot (V)–C (crot) system	--------	HP	28	40	45	35	------	------	22
86	Cot in cot-O-lesp seed, RdL	--------	HP	23	34	40	30	------	------	--------
87	Do	--------	MP	25	40	45	37	------	------	--------
88	Cot in cot-SG-sw cl	--------	MP	25	45	48	35	------	------	--------
	SMALL GRAIN IN ROTATION									
	With meadow seeding:									
	In disked row-crop residue—									
9	After 1 year C after M	3–5	75+	------	20	12	2	2	------	--------
9	Do	2–3	60–74	------	30	18	3	2	------	--------
	Do	1–2	40–59	------	41	25	4–15	2	------	--------
	Do	<1	25–39	------	60	36	5–15	3	------	--------
	After 2d or 3d year C after M	3–5	75+	------	32	19	5	3	------	--------
	Do	2–3	60–74	------	40	24	5	3	------	--------
	Do	1–2	40–59	------	58	35	5–15	3	------	--------
	Do	<1	25–39	------	75	45	6–15	3	------	--------
	After 1 or more C after SG	--------	--------	------	(6)	(6)	(6)	(6)	------	--------

See footnotes at end of table.

TABLE 2.—*Ratio of soil loss from cropland to corresponding loss from continuous fallow*—Continued

Line No.	Cover, sequence, and management [1]	Productivity [2]		Soil-loss ratio for crop-stage period [3]						
		Hay yield	Corn yield	F	1	2	3 [4]	4L	4R	4L+WC
	SMALL GRAIN IN ROTATION—continued									
	With meadow seeding—Continued									
	In disked row-crop residue—Con.	*Tons*	*Bu.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
98	After 1st-year cot after M	2–3			35	25	5–15	3		
99	After 2d-year cot after M	2–3			50	35	5–15	3		
100	In cot middles after sw cl or lesp				30	22	10–15	3		
	On disked row-crop stubble, RdR—									
101	After 1 year C after M	2–3	60+		50	40	5–15	3		
102	Do	1–2	40–59		80	45	7–15	3		
103	After 2 years C after M	2–3	60+		80	50	6–15	3		
104	After C, 3d year after M				92	55	7–15	3		
	On plowed seedbed, RdL—									
105	After 1 year C or SG after M	3–5	75+	25	45	30	5	3		
106	Do	2–5	60–74	35	51	34	5	3		
107	Do	1–2	40–59	42	60	40	7	4		
108	After 2 years C or SG after M	3–5	75+	36	60	40	5	3		
109	Do	2–3	40–59	55	70	45	7	4		
	On plowed seedbed, RdR—									
110	After 1 year C or SG after M	3–5	75+	55	60	40	5	3		
111	Do	2–3	60–74	60	65	42	6	3		
112	Do	1–2	40–59	65	70	45	7	4		
113	After 2 years C after M	2–3	60–74	65	70	45	7	4		
	Without meadow seeding:									
114	Sequences and yields of lines 89–90			(7)	(7)	(7)	8	8	16	
115	Sequences and yields of lines 91–99, 101, 105, 106, 108–110			(7)	(7)	(7)	10	10	20	
116	Sequences and yields of lines 102–104, 107, 111-113			(7)	(7)	(7)	12	12	25	
	DOUBLE-CROPPED ROTATIONS									
117	Wheat (grain) and lesp (hay)				25	25	5	5		
118	Wheat and lesp, both grazed				25	25	12	6		
119	Spg oats (hay) and lesp (hay) [8]				50	18	5	5		
	ESTABLISHED MEADOWS [9]									
120	Grass and legume mix	3+						0. 4		
121	Do	2						. 6		
122	Do	1						1. 0		
123	Alfalfa	2. 5+						2. 0		
124	Lespedeza							2. 0		
125	Red clover							1. 5		
126	Sericea, 2d year							2. 0		
127	Sericea, after 2d year							1. 0		
128	Sweetclover							2. 5		

[1] Symbols: C, corn; conv till, conventional tillage; cot, cotton; crot, crotolaria; gr & lg, grass and legume; lesp, lespedeza; M, grass and legume meadow, at least 1 full year; min till, minimum tillage; O, oats; prec, preceding; RdL, residue of prior crop left; RdR, residue of prior crop removed; spg, spring; SG, small grain; sw cl, sweetclover; TP, turn plow; V, vetch; WC, grass or grass-and-legume winter cover seeded early.

[2] For cotton, HP=high crop productivity; MP=moderate crop productivity.

Small-grain cover is assumed commensurate with the indicated productivity level of corn or cotton.

[3] Crop-stage periods are as defined on p. 10. Period 4 ratios are taken from column 4L when crop residues remain on field but without winter cover seeding; from column 4R when corn stover, straw, and similar residues are removed; and from column 4L+WC when early-seeded grass and legume winter cover is established in addition to leaving crop residues.

[4] Where two period 3 values appear, the first is for high-yielding grain and the second is for grain yielding less than 30 bushels of oats or 15 bushels of wheat per acre.

[5] Use data from lines 36 to 42, selecting line on basis of productivity level.

[6] Use data from lines 93 to 96, selecting line on basis of productivity level.

[7] Use data from lines 89 to 113.

[8] Ratio for winter months is 12 percent.

[9] Ratios shown are the yearly averages.

TABLE 3.—*Suggestions for approximating soil-loss ratios for cropping and management combinations not listed in table 2*

Cover, sequence, and management	Soil loss ratios
Corn:	
After fall turnplowing in northern half of United States.	To compensate for effect of freezing and thawing and for high early-spring soil moisture content, add 7 to each period-F and period-1 value in lines 1 to 7, 13 to 18, 33 to 39, and 47 to 50 of table 2.
After 2 or more full years of meadow.	Table 2 assumed at least 1 full year of established grass-and-legume meadow. Additional credit for 2-year meadows may be considered if meadows are high yielding and are not permitted to deteriorate: Reduce by 10 percent the values for periods F, 1, 2, 3 and 4L in lines 13, 14, 15, 33, 34, 66, 67, 78, and 79.
With small-grain seeding for winter cover.	Small grain turned early in spring does not significantly reduce soil loss from following corn crop. Select lines from table 2 that do not specify WC seeding and substitute small-grain periods 1 and 2 for corn period 4L or 4R.
Grain sorghum	Same as ratios for corn in similar rotations where canopy cover and quantities of residue are comparable. Under irrigation, the values for grain sorghum may equal those for high-yielding corn.
Meadow:	
New	When seeded without a nurse crop, use values listed for spring-seeded small grain. The lengths of periods 1 and 2 should be adjusted if necessary so that cover in each period will be comparable to corresponding grain periods.
Established	Apply values of lines 120 to 128.
Peanuts	For comparable crop sequence, values in lines 5, 6, 16, 17, 27, 28, 32, 35, 38, 45, 49, 52, and 56 are recommended.
Potatoes:	
After potatoes or truck crop	In similar crop sequence, select values from periods F, 1, 2, and 4 of lines 18, 29, 39, 46. For period 3, use values from line 16, 17, 27, 28, 38, or 45.
After grass-and-legume hay yielding more than 2 tons per acre.	Select values for periods F to 3 from lines 1, 3, 5, 7 on basis of hay yield; period 4 from line 7.
After corn or small grain	Select values for periods F to 3 on basis of preceding crop and yield; period 4 from line 7.
Soybeans:	
After grass-and-legume hay or after corn.	Use values for comparable corn rotations: Periods F to 3 from lines 3 to 7, 15 to 18, 26 to 29, 37 to 39, 48, 49; period 4 from lines 7, 18, 29, 39.
After soybeans	Select lines representing corn residues equivalent to soybean residues: Lines 15 to 18, 37 to 39.
Late-planted	Select values from comparable crop sequences in lines 5, 6, 16, 17, 27, 28, 32, 35, 38, 45, 49.
Sweet corn	Do.
Truck crops	For low-residue truck crops after grass-and-legume hay or high-residue crops, select periods F and 1 values from comparable corn rotations; periods 2, 3, and 4 values from lines 7, 18, 29, 39, 46. For second or more year of truck crop, use values from line 39 or 46 for all periods.

Other combinations of crops and management variables are being included in studies as rapidly as possible. Rainfall simulators have been developed to decrease the time required to obtain data. In the meantime, the data in table 2 will be helpful for estimating the effectiveness of covers or management practices that have not been measured directly. Such estimates are facilitated by the fact that the table values are given for each crop-stage period separately. Cover and surface conditions as they occur in each crop-stage period of an untested crop or with a new tillage practice may usually be compared with the conditions reflected in one of the lines of soil-loss ratio table. This procedure is illustrated in table 3, which suggests a number of specific comparisons.

Semiarid Areas.—Water erosion is a serious problem also in most semiarid regions. Inadequate moisture and periodic droughts reduce the periods when growing plants provide good soil cover and limit the total quantities of plant residues produced. Erosive rainstorms are not uncommon, and they are concentrated within the season when cropland is least protected. Because of the difficulty of establishing meadows and the competition for available soil moisture, sod-based rotations are often impractical.

Proper management of available residues offers one of the most important opportunities for a higher level of soil and moisture conservation. However, accurate soil-loss ratios for stubble mulching and summer fallowing practices on the western Plains are not yet available from research data. The ratios given in table 4 are approximations based on observations of experi-

TABLE 4.—*Approximations of soil-loss ratios for crop-stage periods and number of tillage operations with stubble mulching and summer fallowing in western Plains areas*

Cover, sequence, and management	Residue on surface at seeding time	Soil-loss ratios for crop-stage period—				
		1	2	3	4L	4R
Small grain without meadow seeding:	*Pounds*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
After small grain	200–500	70	45	6	10	20
Do	500–1, 000	42	25	6	10	20
Do	1, 000–1, 500	25	17	6	10	20
Do	1, 500–2, 000	15	10	6	10	20
After summer fallow of—						
Small-grain residues	0–200	90	55	6	10	20
Do	200–500	70	45	6	10	20
Do	500–1, 000	42	25	6	10	20
Do	1, 000–1, 500	25	17	6	10	20
Do	1, 500–2, 000	15	10	6	10	20
Row crop residues	0–200	90	55	6	10	20
Do	200–500	85	50	6	10	20
Do	500–1, 000	70	45	6	10	20
Do	1, 000–1, 500	50	35	6	10	20
Do	1, 500–2, 000	40	30	6	10	20
Do	2, 000–2, 500	30	25	6	10	20
		Soil-loss ratios for following number of tillage operations after grain harvest—				
		1	2	3	4	5
Summer fallow:						
After small grain	0–200	53	60	70	80	90
Do	200–500	25	49	55	63	70
Do	500–1, 000	25	29	34	39	42
Do	1, 000–1, 500	10	14	19	22	25
Do	1, 500–2, 000	4	6	8	11	13
After row crop	0–200	68	72	80	85	90
Do	200–500	50	55	63	75	85
Do	500–1, 000	50	55	60	65	70
Do	1, 000–1, 500	26	35	40	45	50
Do	1, 500–2, 000	20	25	30	35	40
Do	2, 000–2, 500	15	20	25	28	30

enced field personnel,[5] guided by very limited data on the erosion-control effectiveness of various amounts of surface mulch and by the experimentally determined values of table 2. These approximations appear to be consistent with present knowledge of erosion research and runoff and will provide valuable guides until more precise evaluations can be obtained through additional research.

Erosion-Index Distribution Curves

The rainfall factor, R, in the erosion equation does not completely describe the effects of locational differences in rainfall pattern on soil erosion. On cropped fields, rainstorm distribution within the year is also important. The erosion-control effectiveness of a cropping system on some particular field depends, in part, on how the year's erosive rainfall is distributed among the five crop-stage periods of each crop included in the system. Therefore, expected monthly distribution of erosive rainfall at a particular location is an element in deriving the applicable value of the cropping-management factor, C.

It was previously pointed out that a location's erosion index is computed by summing EI values of individual storms. Thus, the monthly distribution of the erosion index can also be determined from long-time rainfall data. This was done for all the station rainfall records abstracted for development of the iso-erodent map.

On the basis of monthly distribution of the erosion index, the 37 States of figure 1 were

[5] The authors are indebted to D. G. Craig, W. A. Hays, J. J. Pierre, and J. W. Turelle, Soil Conservation Service, for substantial contributions toward expanding the scope and usability of the soil-loss ratio data from which table 2 was derived. Table 4 was taken from unpublished material developed by J. W. Turelle and D. G. Craig, in cooperation with the Agricultural Research Service's runoff and soil loss data center.

livided into 33 geographic areas shown in figure 4. For practical purposes, its monthly distri-)ution may be considered uniform throughout any)ne of these areas but different from monthly listribution in any of the other 32 areas. Actu-ılly, the changes in distribution are usually ;radual transitions from one area to another ather than abrupt changes at the area bound-ries. Therefore, wide differences between aver-ge distributions within two adjacent areas are ften not apparent. However, at some part of he distribution curve, the difference is sufficient o affect *C*-value derivations for some cropping ystems. For widely separated geographic areas, ifferences in the erosion-index distributions are ıuch more apparent.

The erosion-index distribution curve applicable in each of the 33 subareas of figure 4 is shown in figures 5 to 21, respectively. The numbers of the plotted curves in these figures correspond with the area numbers shown on the key map, figure 4. Average monthly erosion-index values were expressed as percentages of average annual values and plotted cumulatively against time. Thus, the percentage of the annual erosion index that is to be expected within any particular crop stage period may be found by reading the curve at the last and first date of the period and subtracting.

Procedure for Deriving Rotation *C*-Values for a Particular Locality

To compute the value of *C* for any particular rotation on a given field, one needs first to determine the most likely seeding and harvest dates

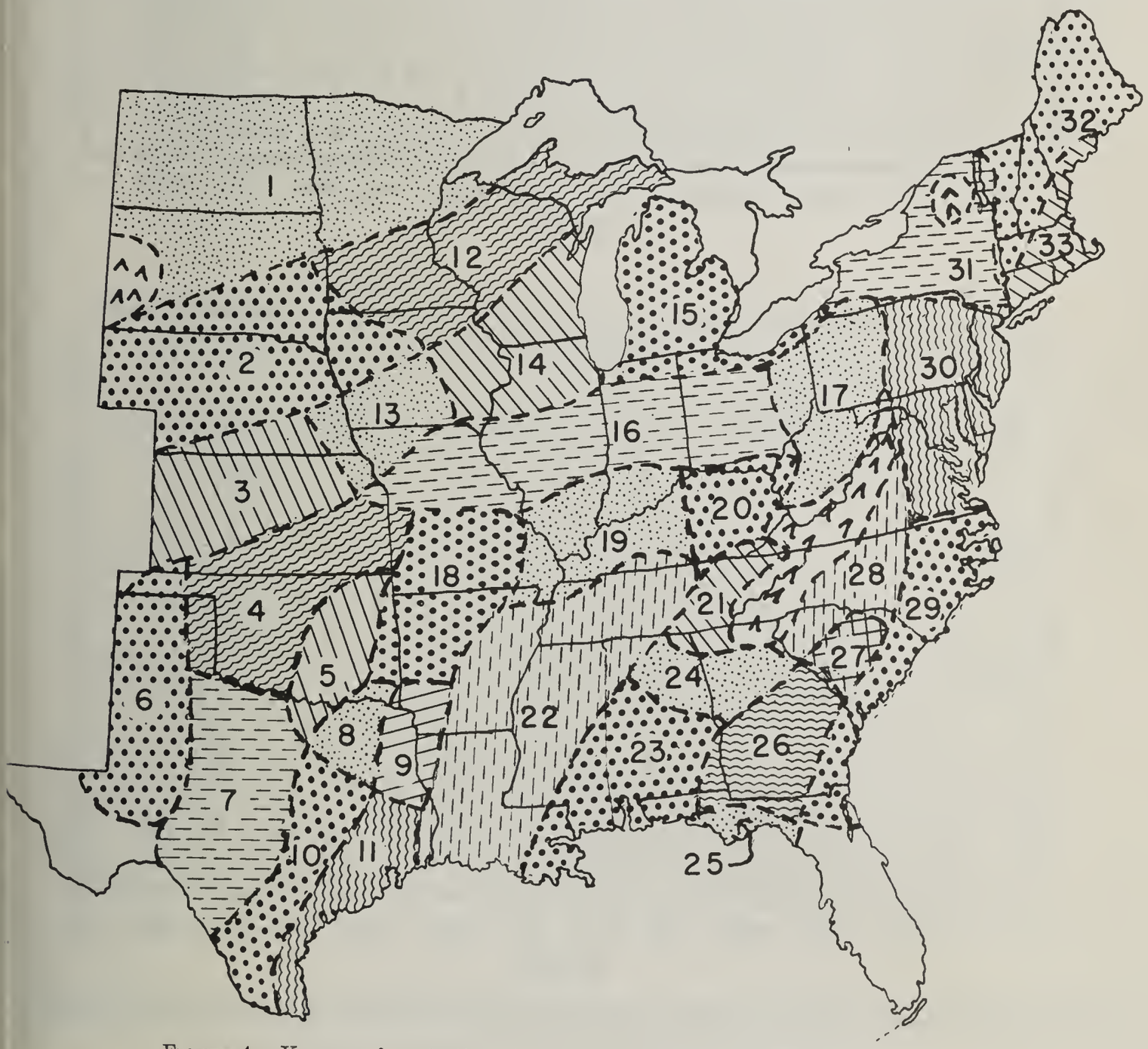


FIGURE 4.—Key map for selection of applicable erosion-index distribution curve.

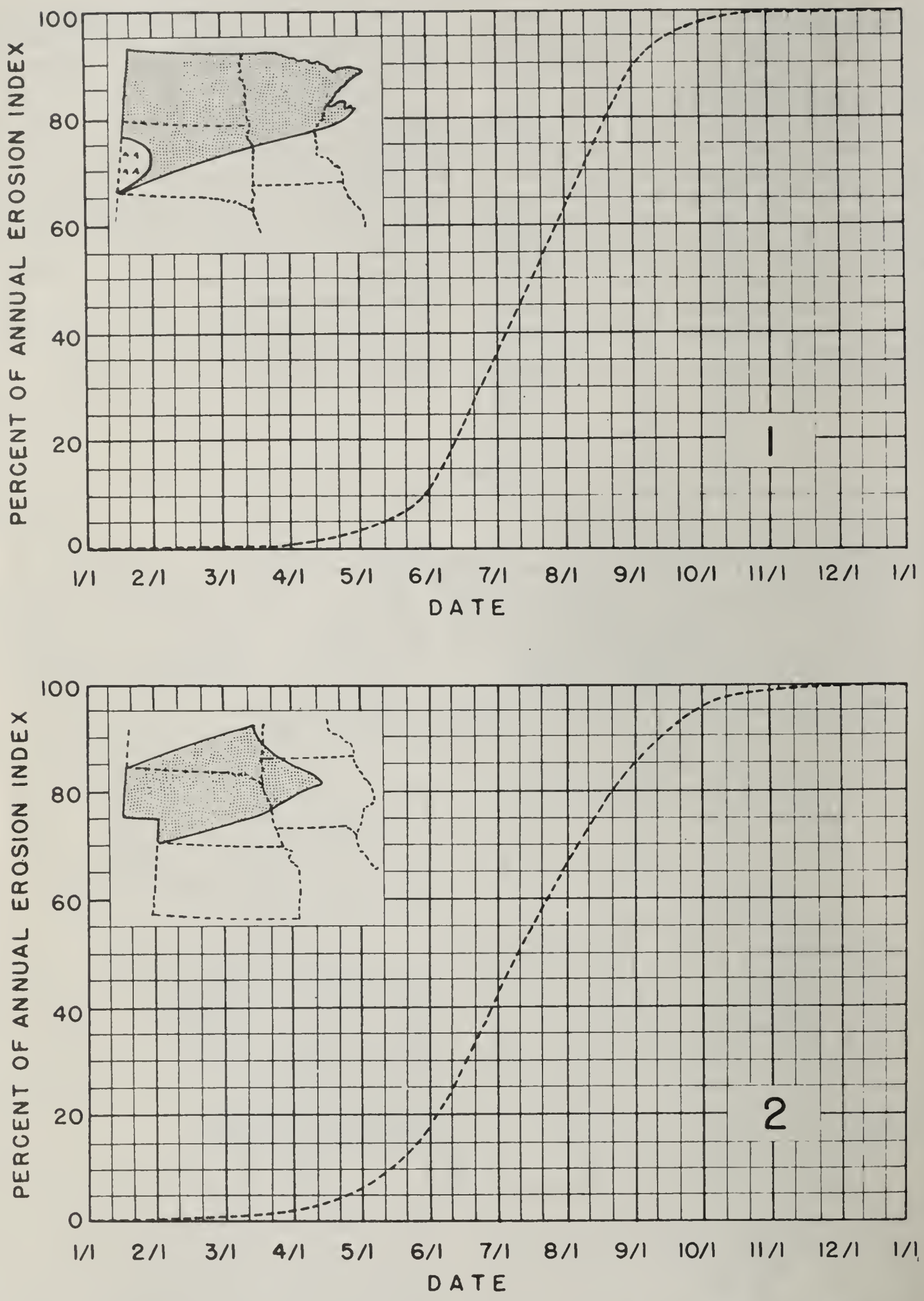
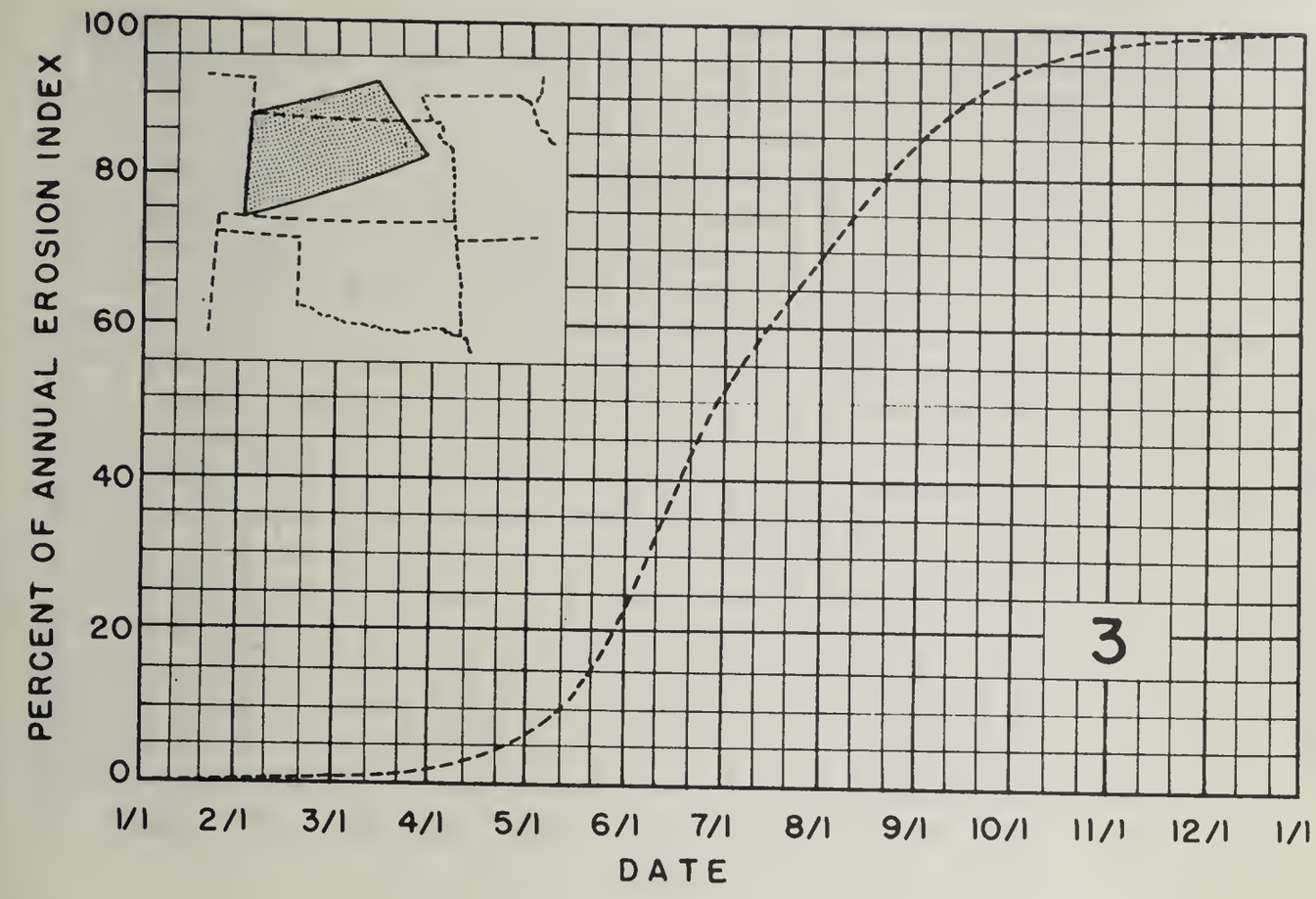


FIGURE 5.—Erosion-index distribution curves 1 and 2: the Dakotas and parts of Minnesota, Nebraska, and Iowa.



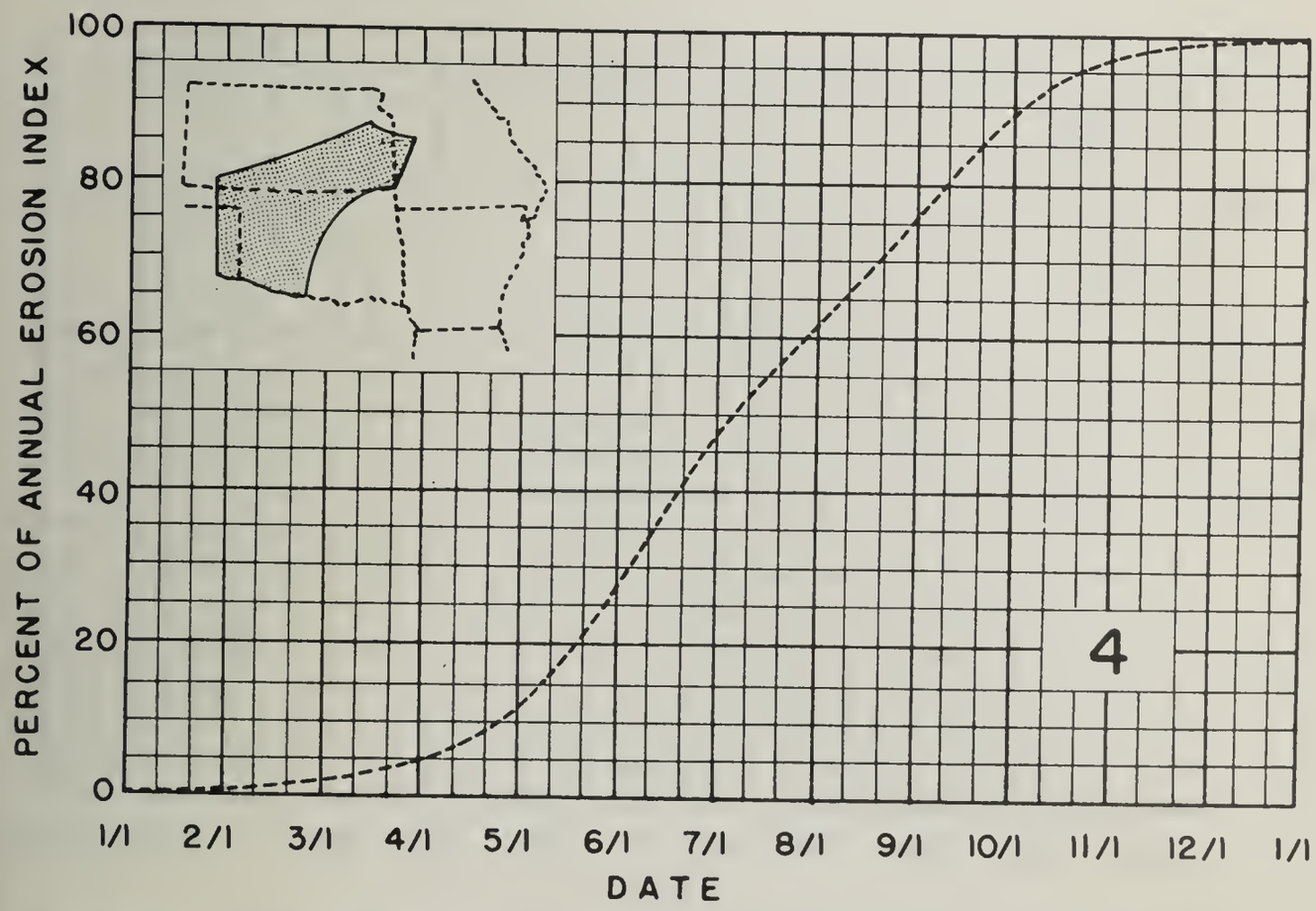
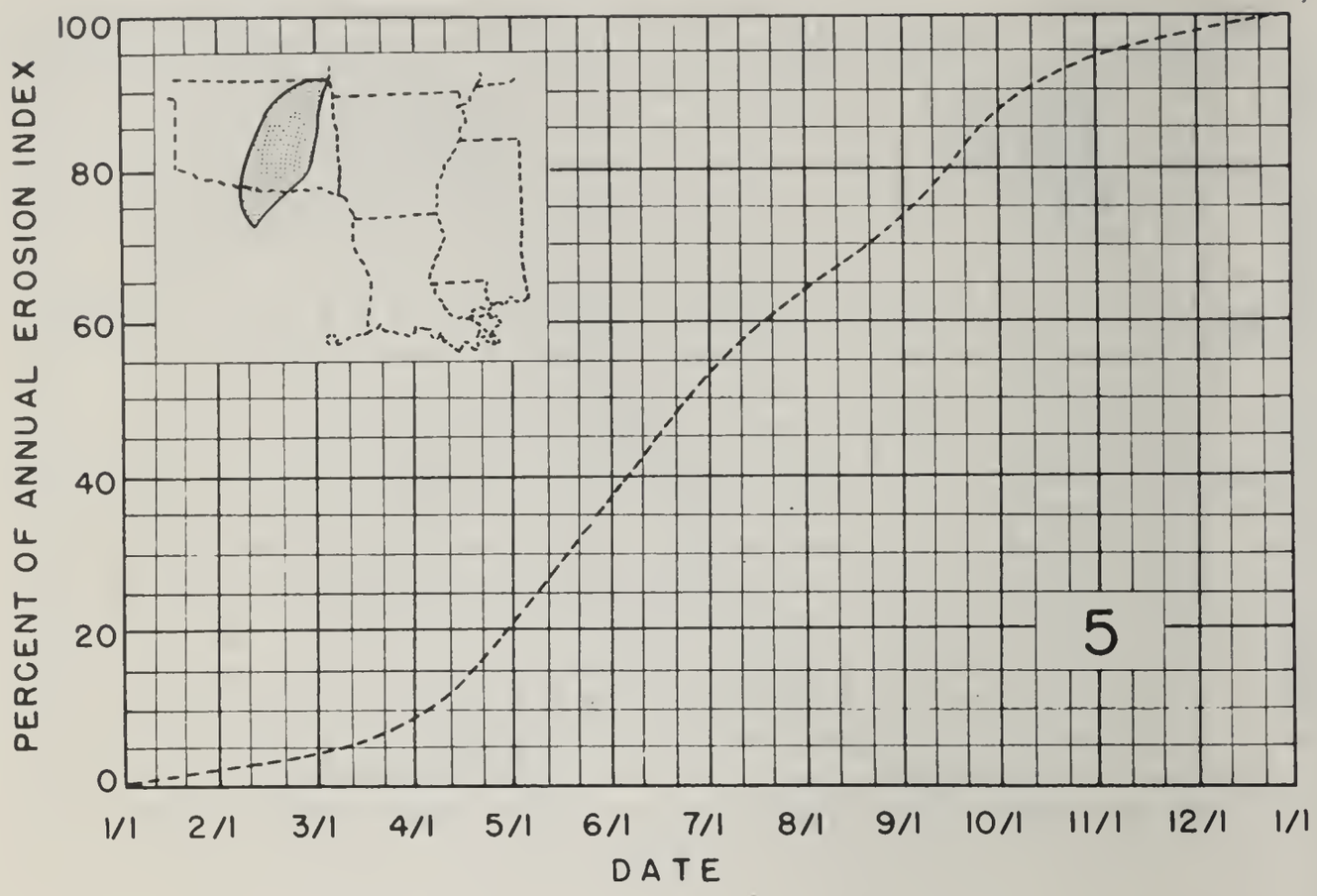


FIGURE 6.—Erosion-index distribution curves 3 and 4: parts of Nebraska, Kansas, and Oklahoma.



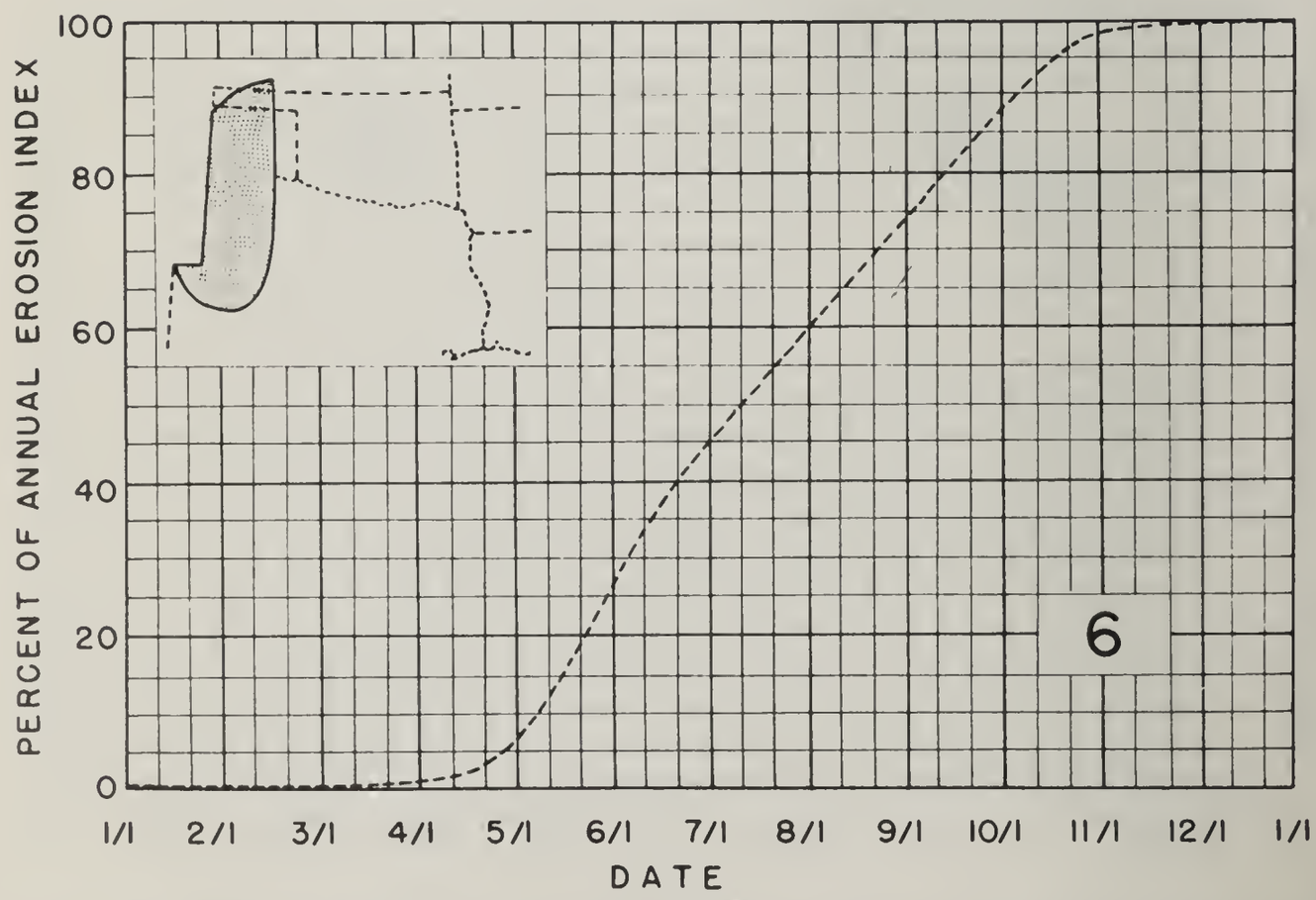
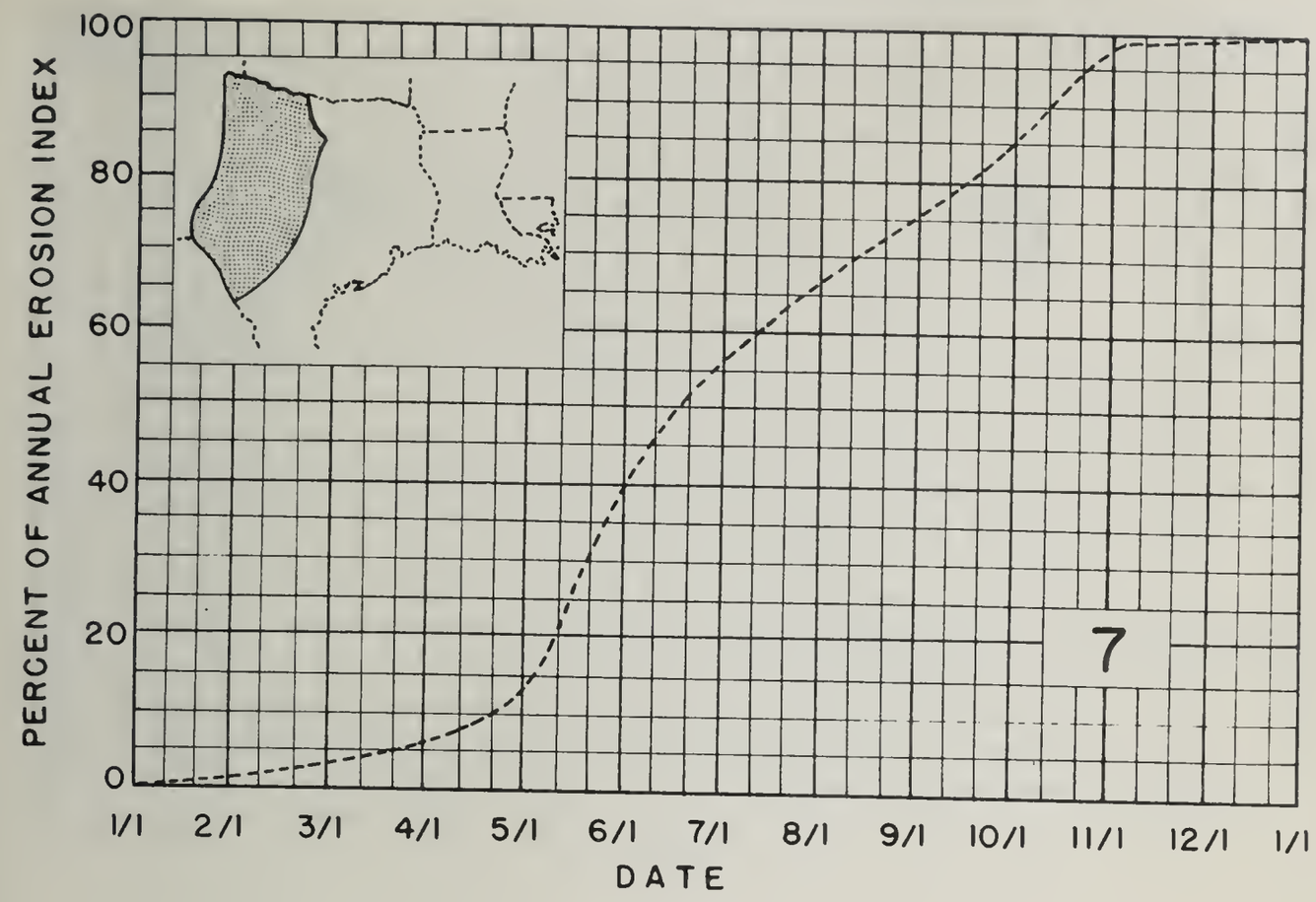


FIGURE 7.—Erosion-index distribution curves 5 and 6: parts of Oklahoma and Texas.



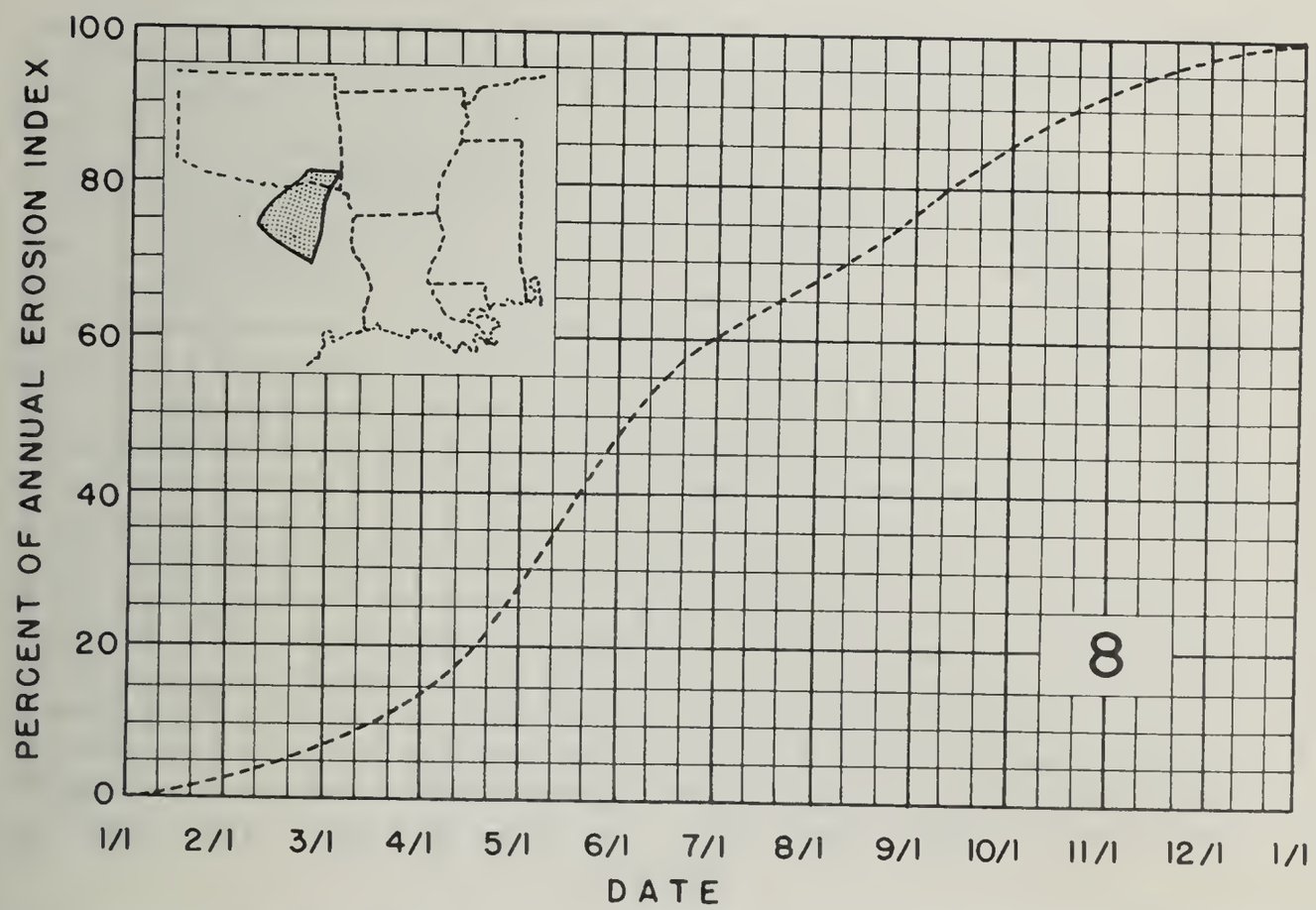
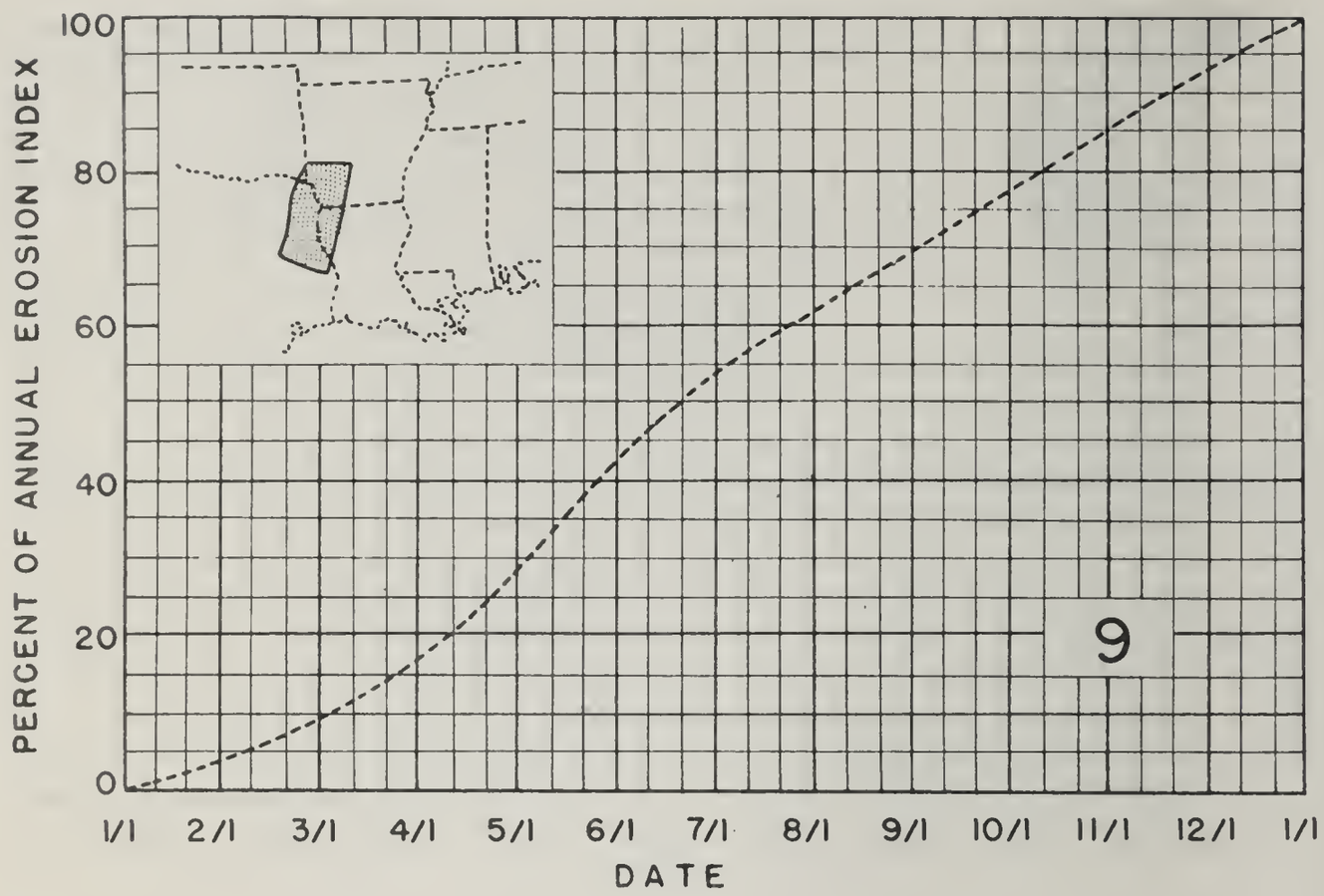


FIGURE 8.—Erosion-index distribution curves 7 and 8: parts of Texas.

760-705 O—65——4



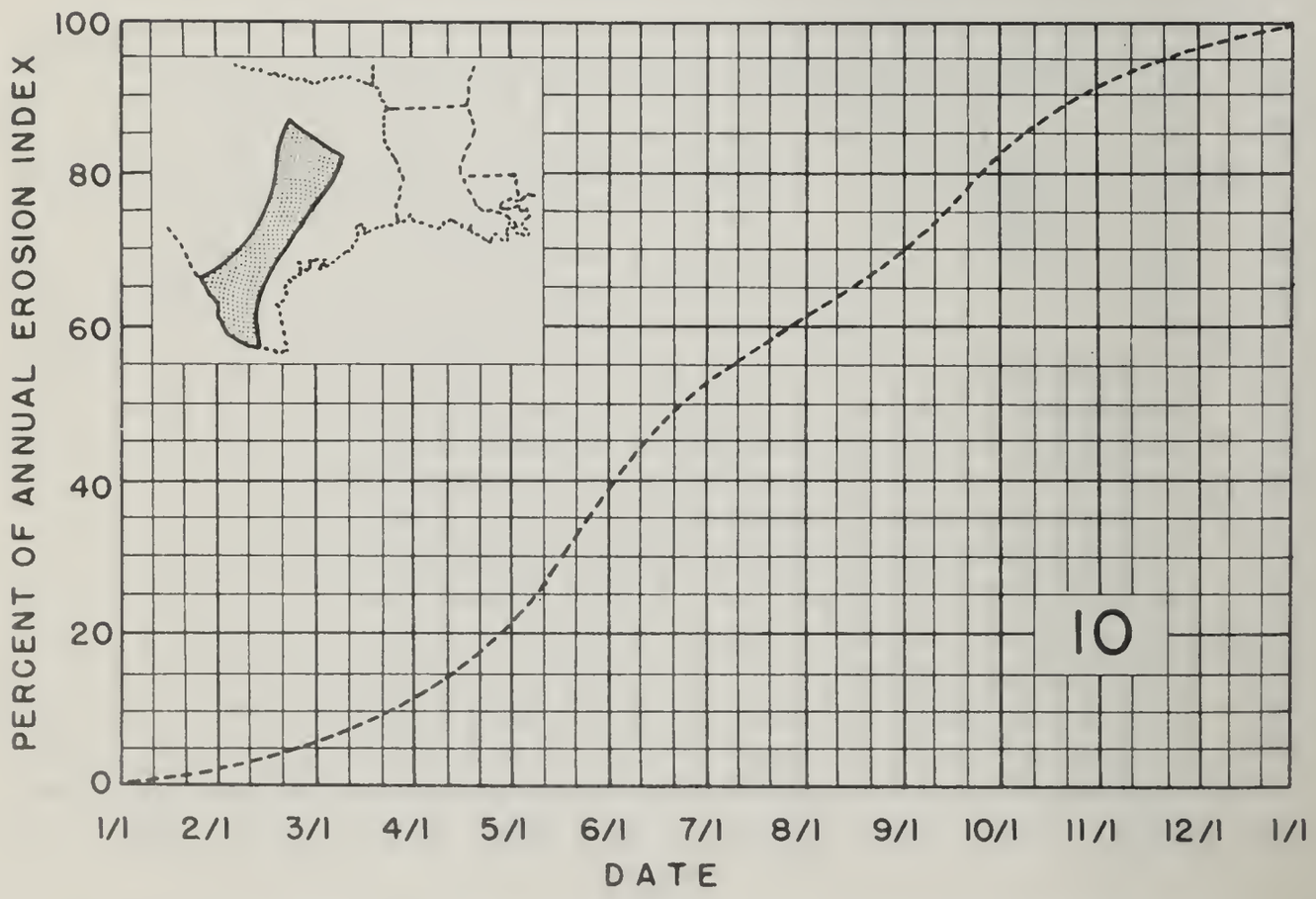
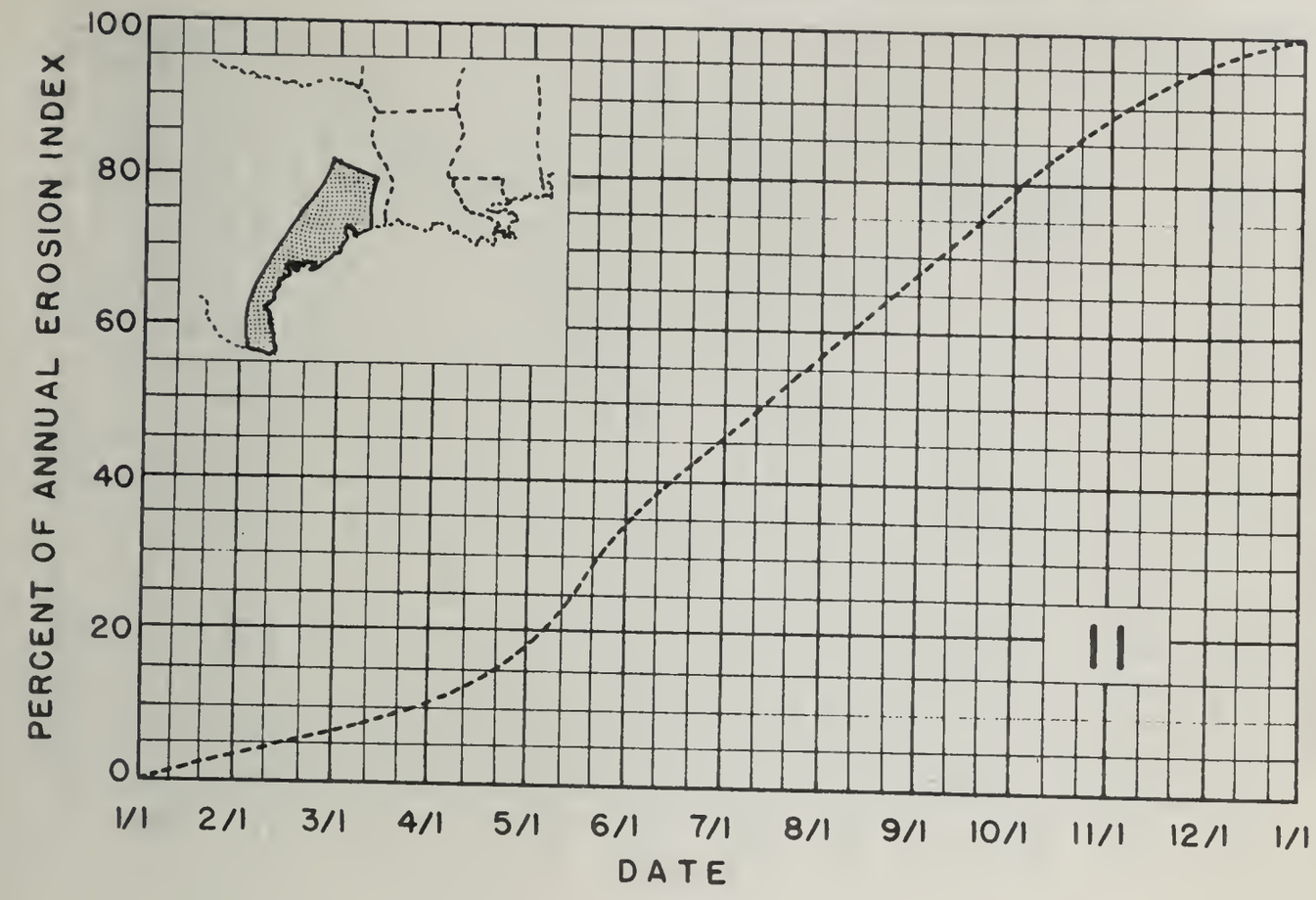


FIGURE 9.—Erosion-index distribution curves 9 and 10: parts of Texas, Arkansas, and Louisiana.



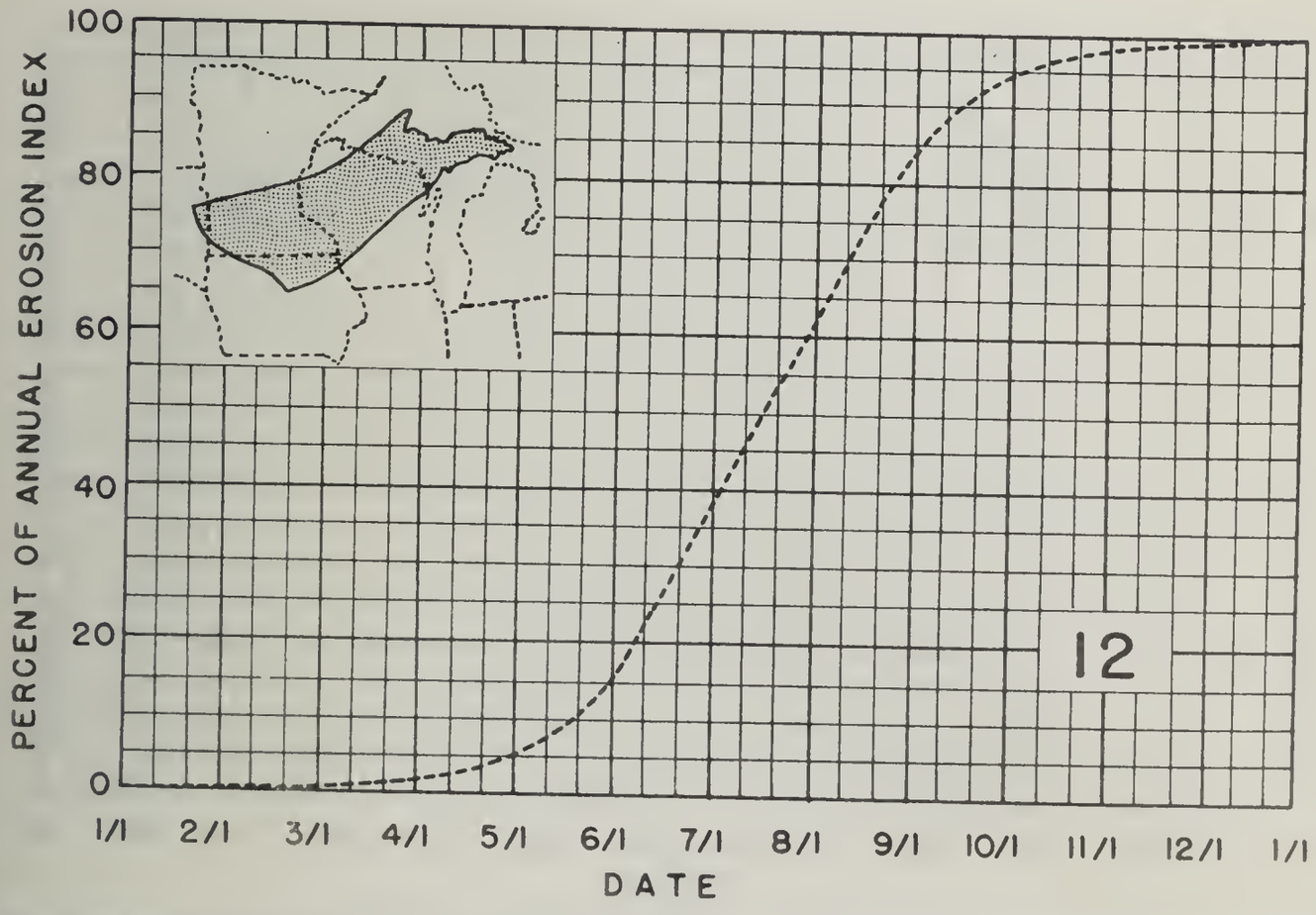
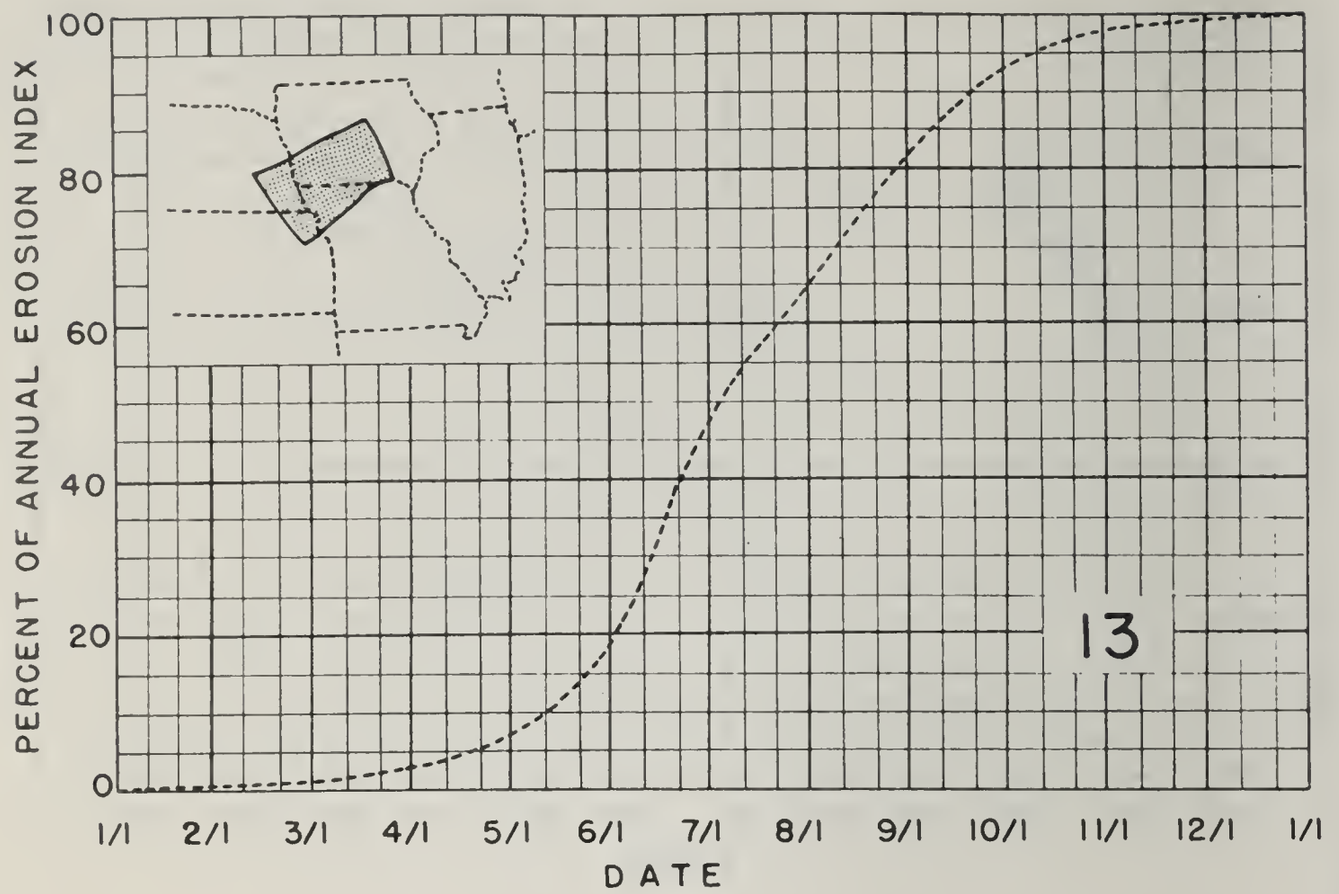


FIGURE 10.—Erosion-index distribution curves 11 and 12: parts of Texas, Minnesota, Iowa, Wisconsin, and Michigan.



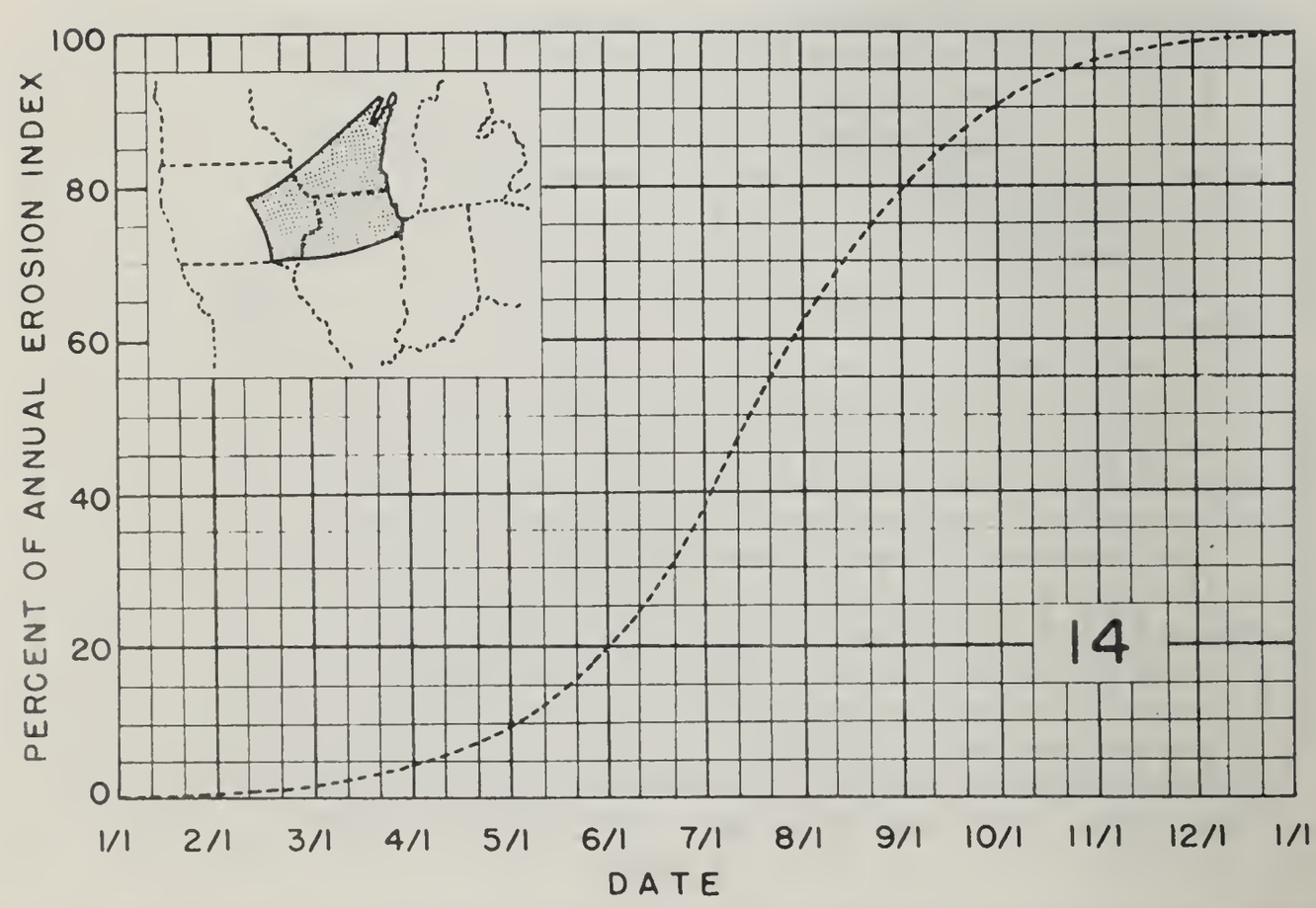
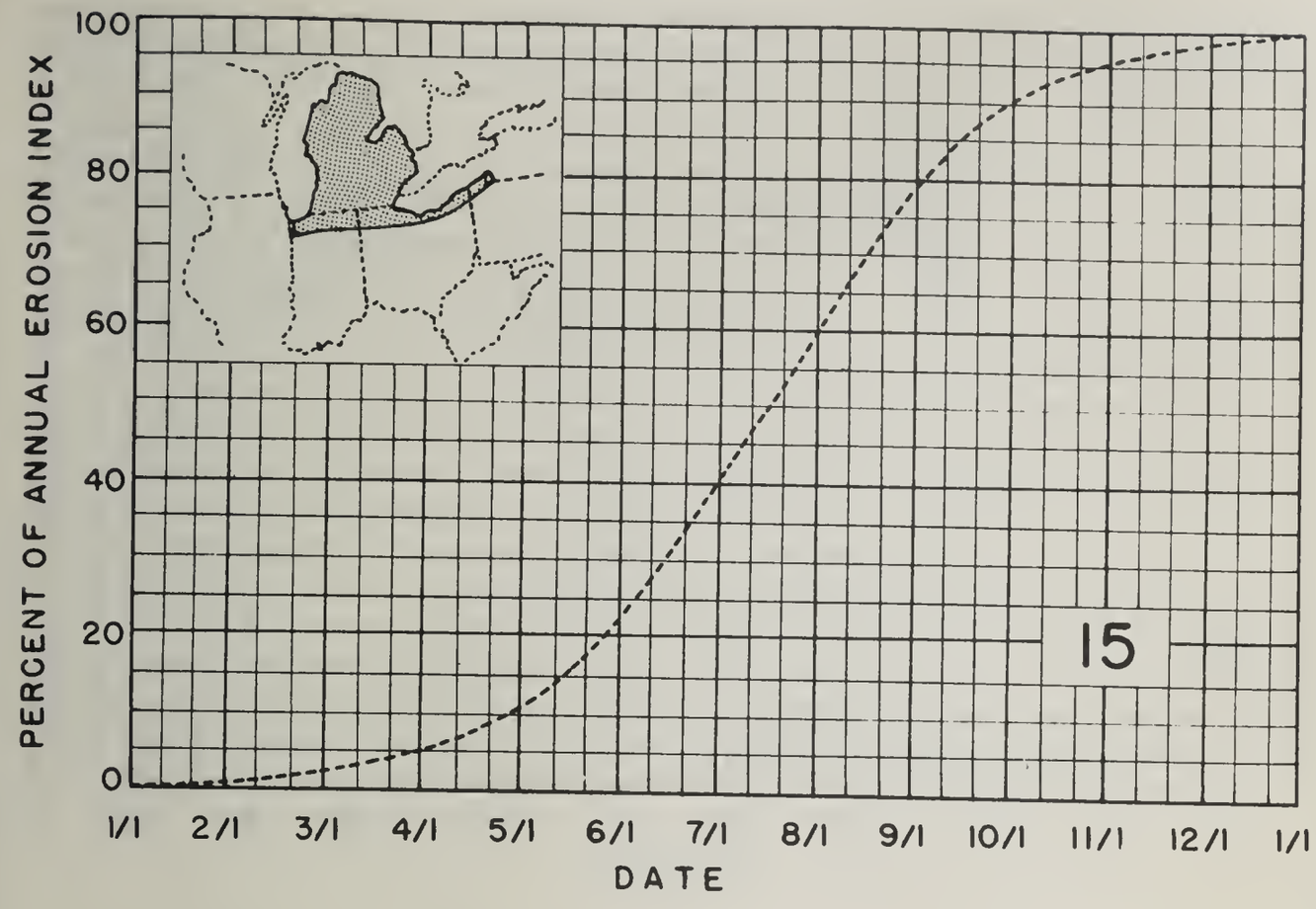


FIGURE 11.—Erosion-index distribution curves 13 and 14: parts of Nebraska, Kansas, Missouri, Iowa, Illinois, and Wisconsin.



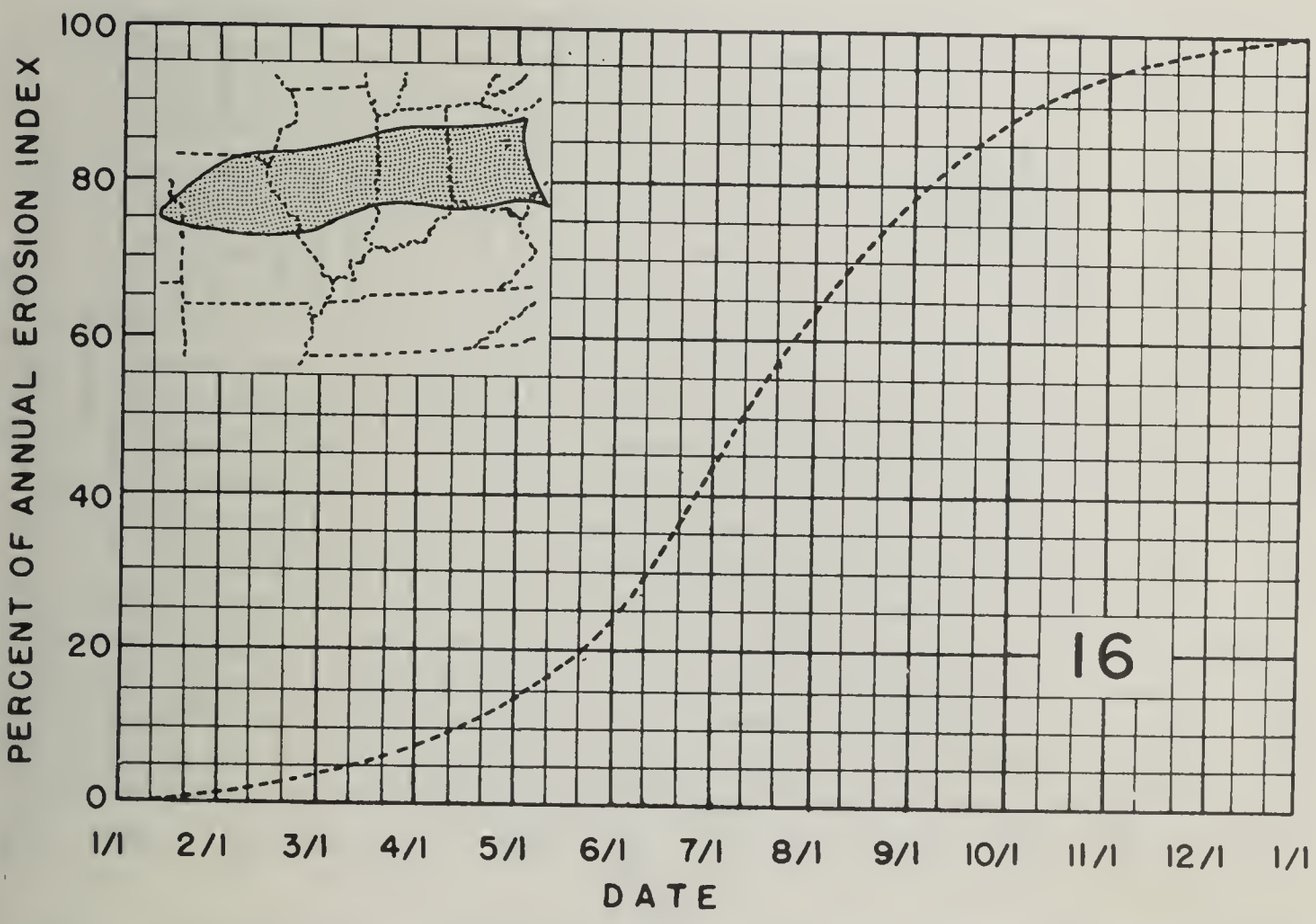
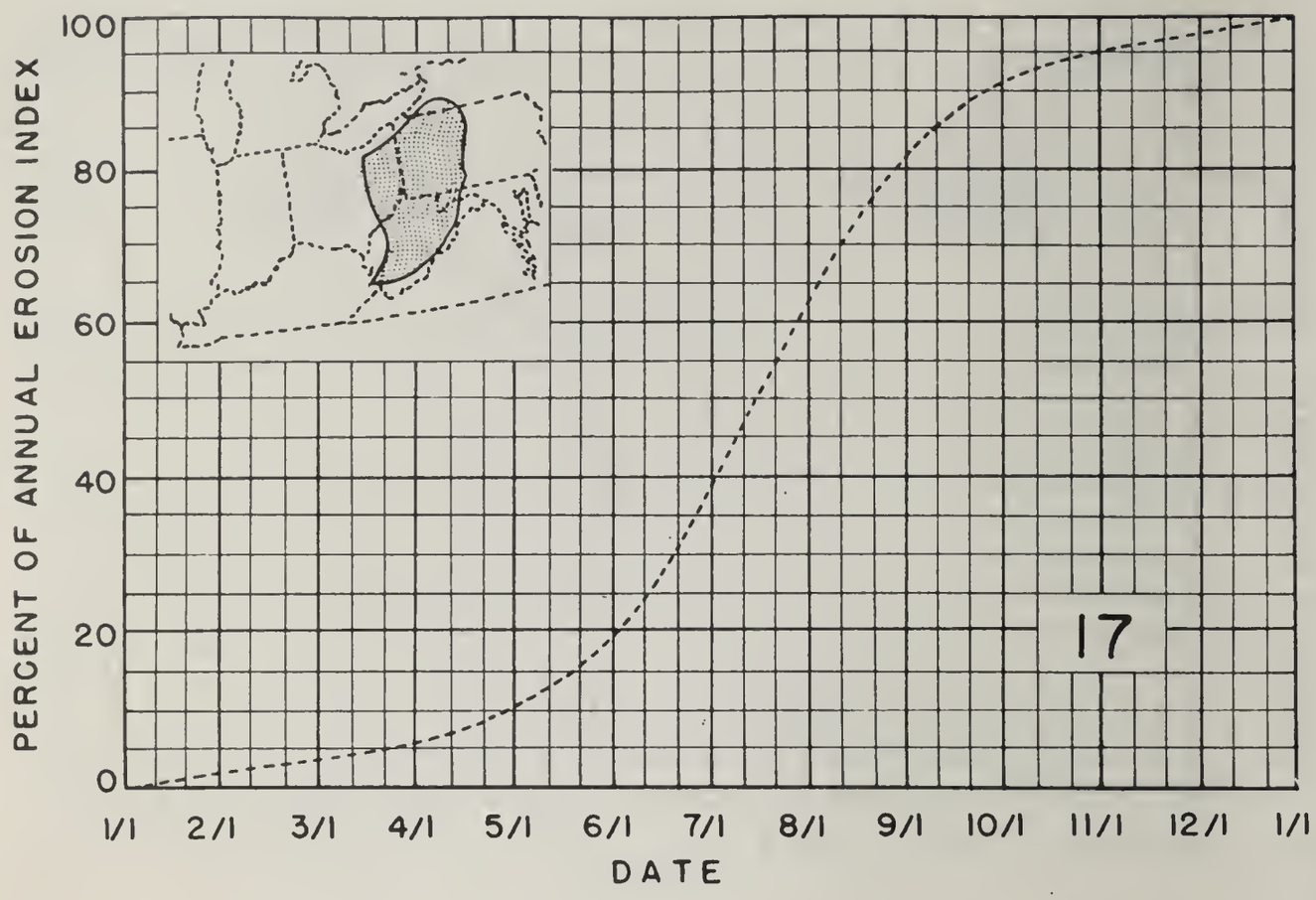


FIGURE 12.—Erosion-index distribution curves 15 and 16: parts of Michigan, Missouri, Illinois, Indiana, and Ohio.



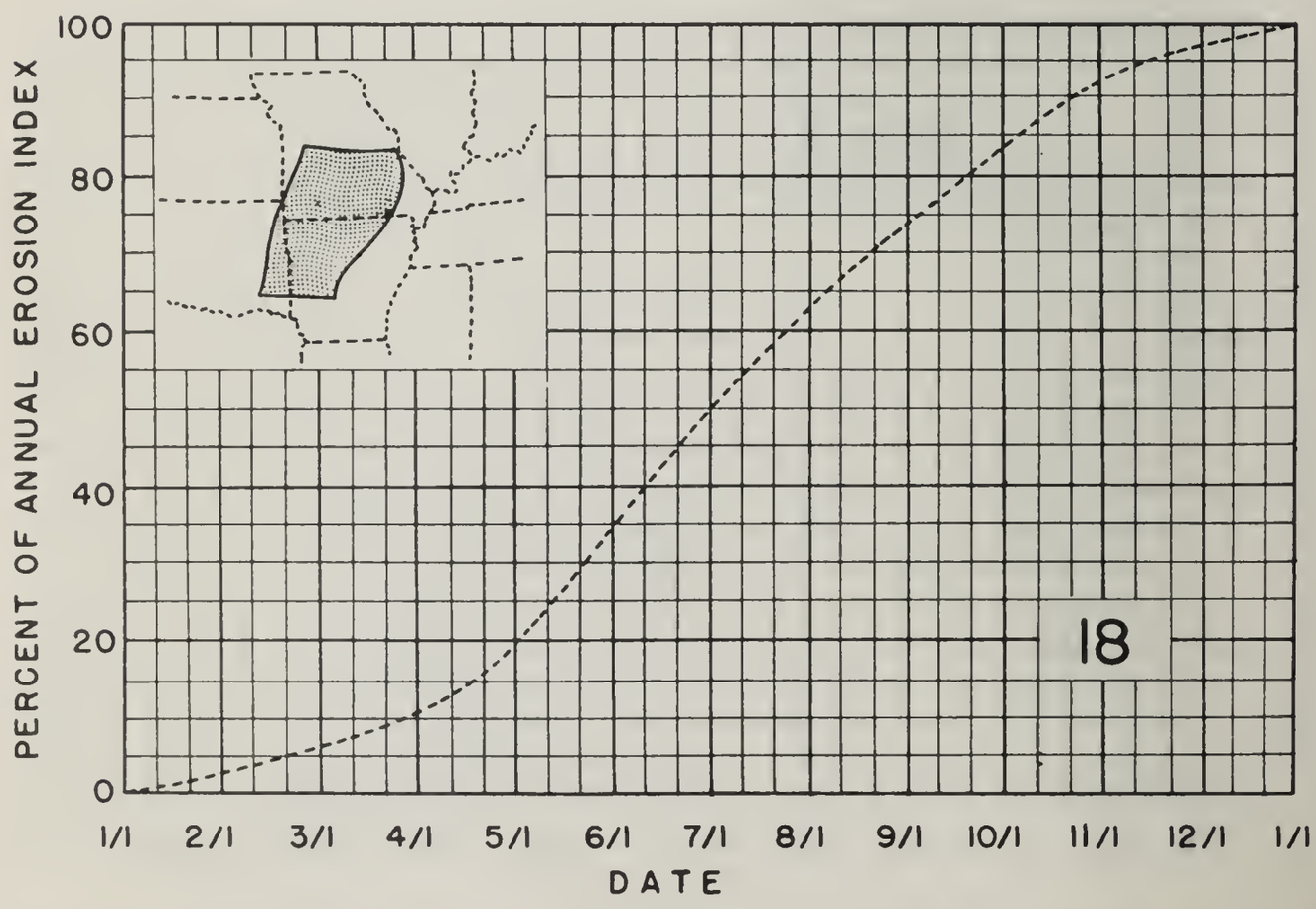
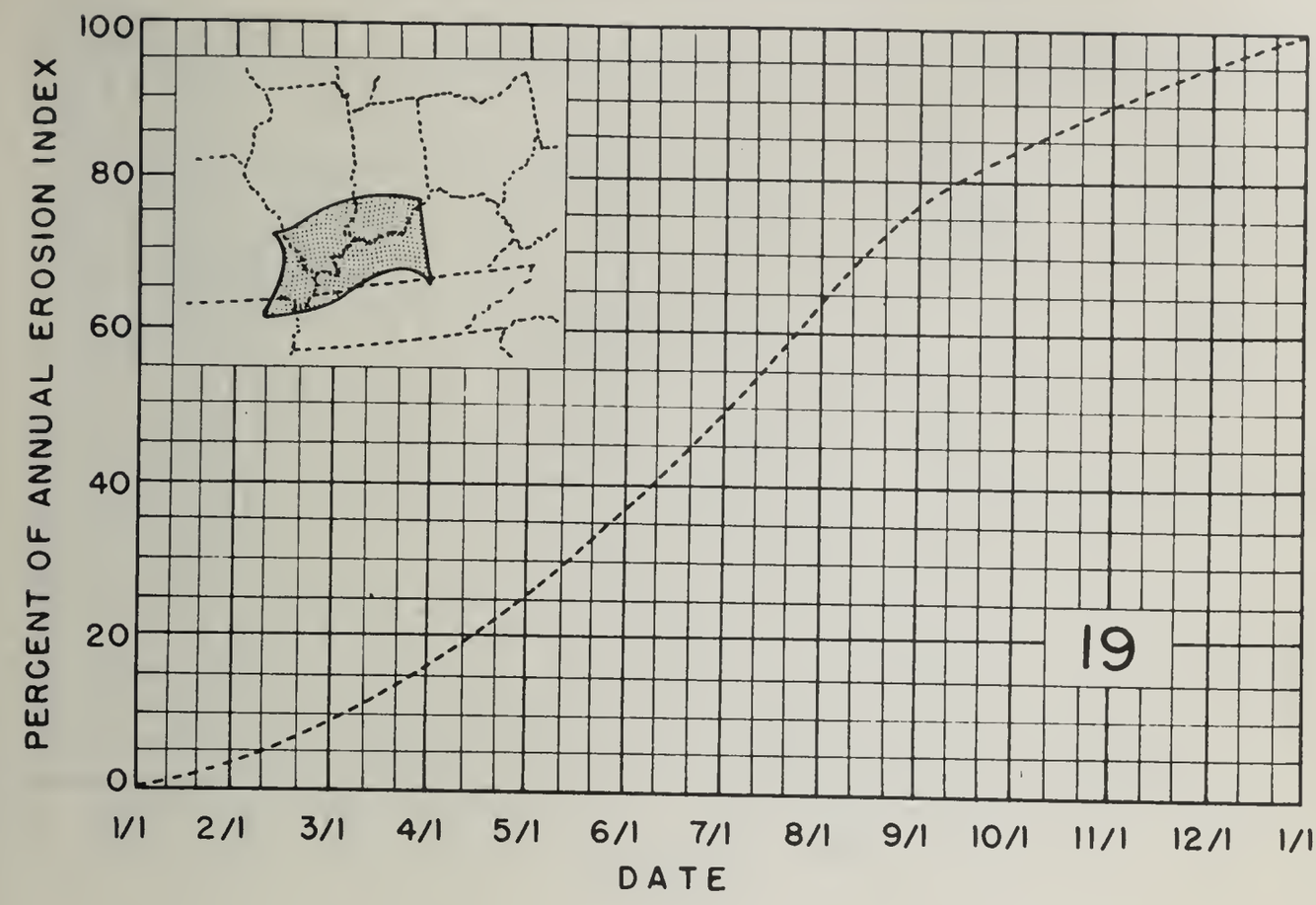


FIGURE 13.—Erosion-index distribution curves 17 and 18: parts of Ohio, Pennsylvania, West Virginia, Missouri, and Arkansas.



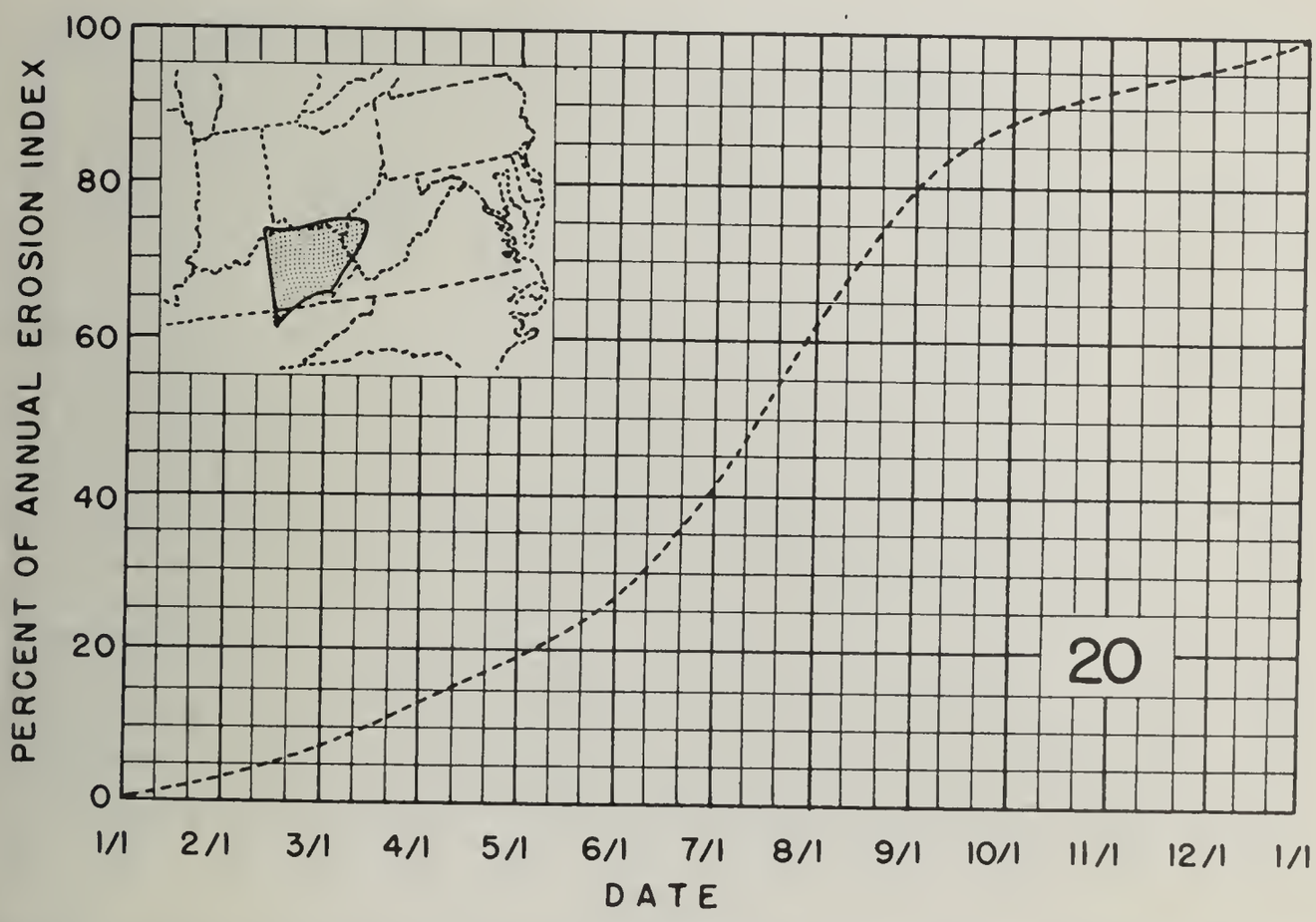
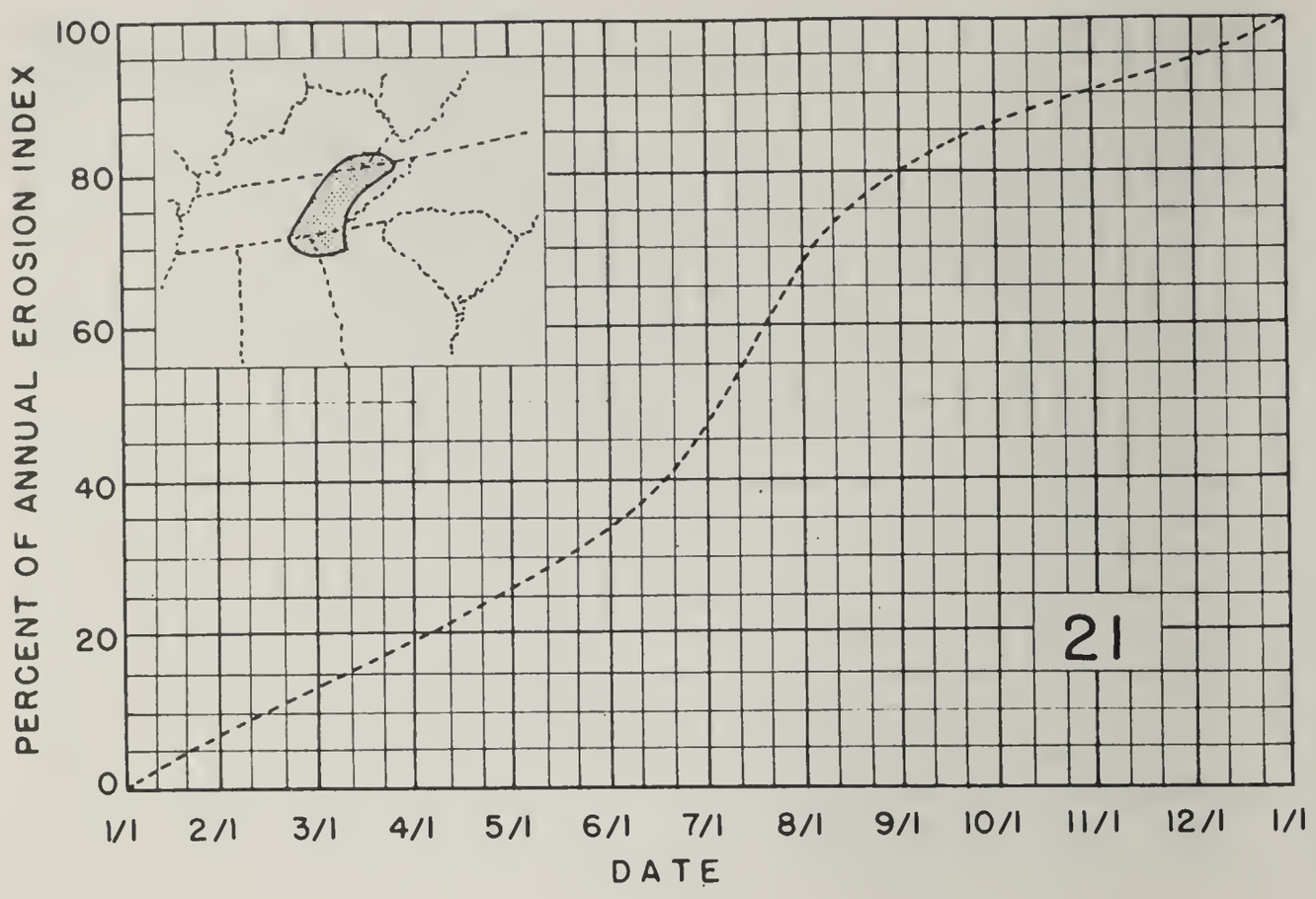


FIGURE 14.—Erosion-index distribution curves 19 and 20: parts of Missouri, Illinois, Indiana, and Kentucky.



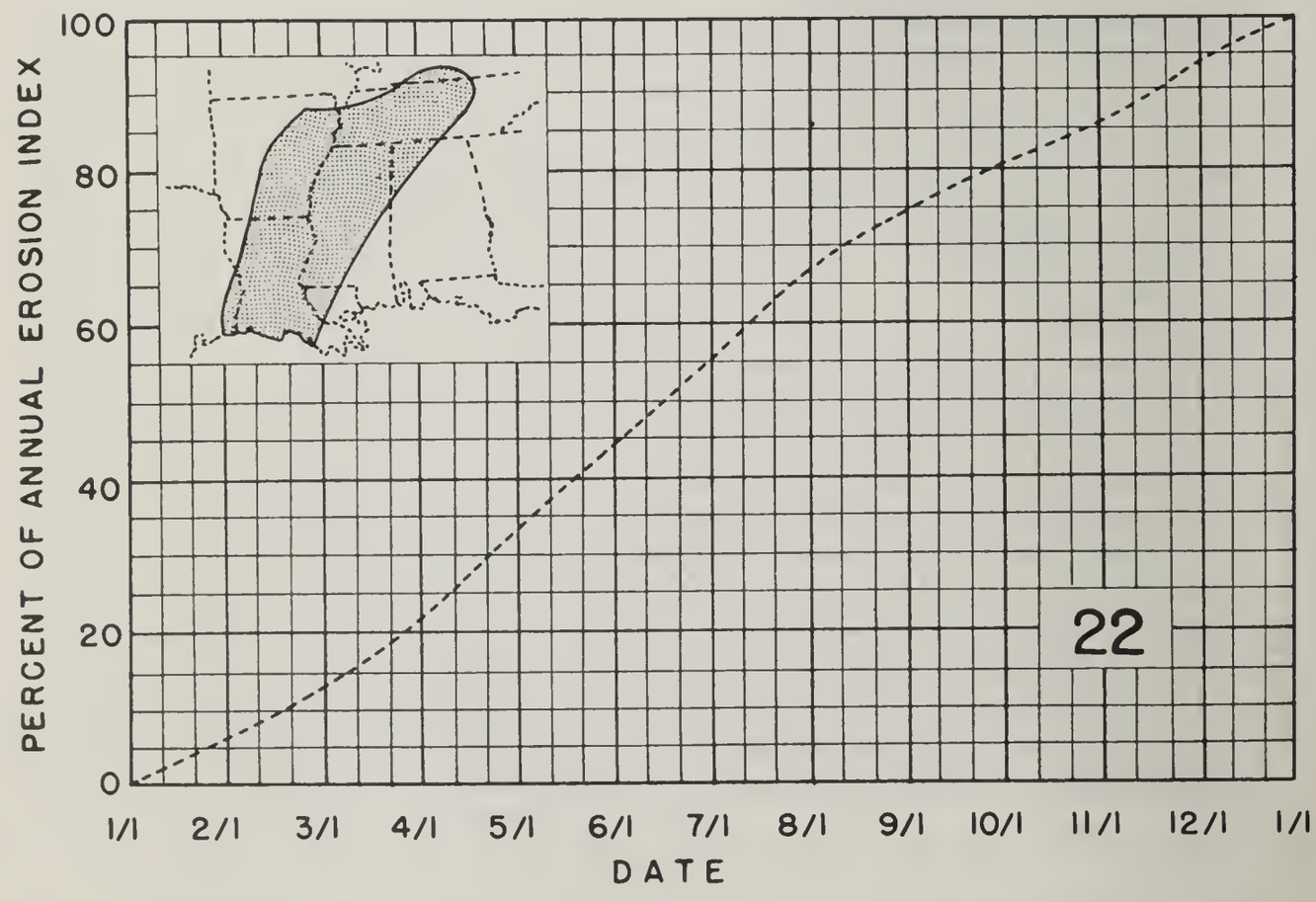
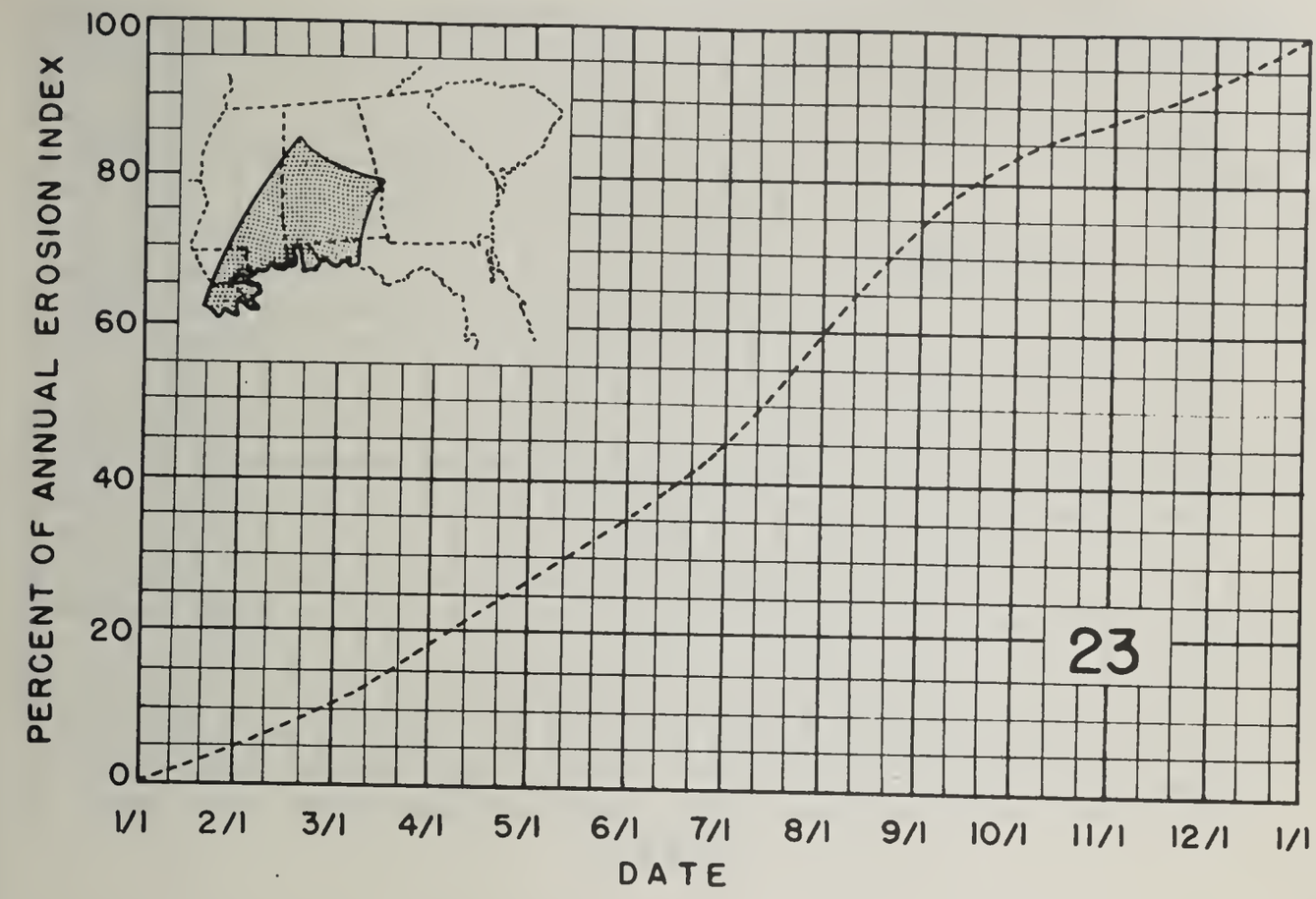


FIGURE 15.—Erosion-index distribution curves 21 and 22: parts of Tennessee, Arkansas, Louisiana, Mississippi, and Alabama.



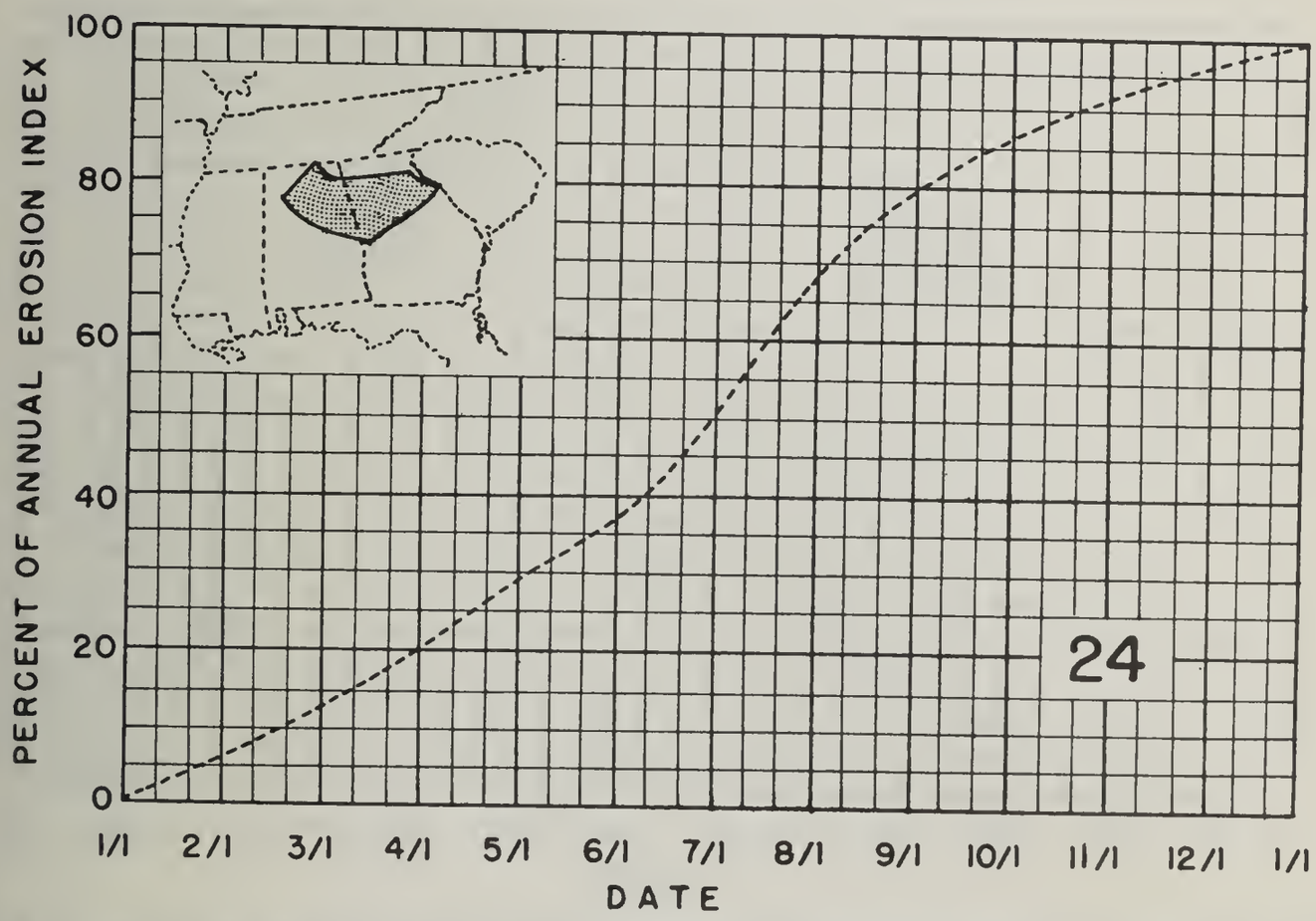


FIGURE 16.—Erosion-index distribution curves 23 and 24: parts of Mississippi, Alabama, Florida, and Georgia.

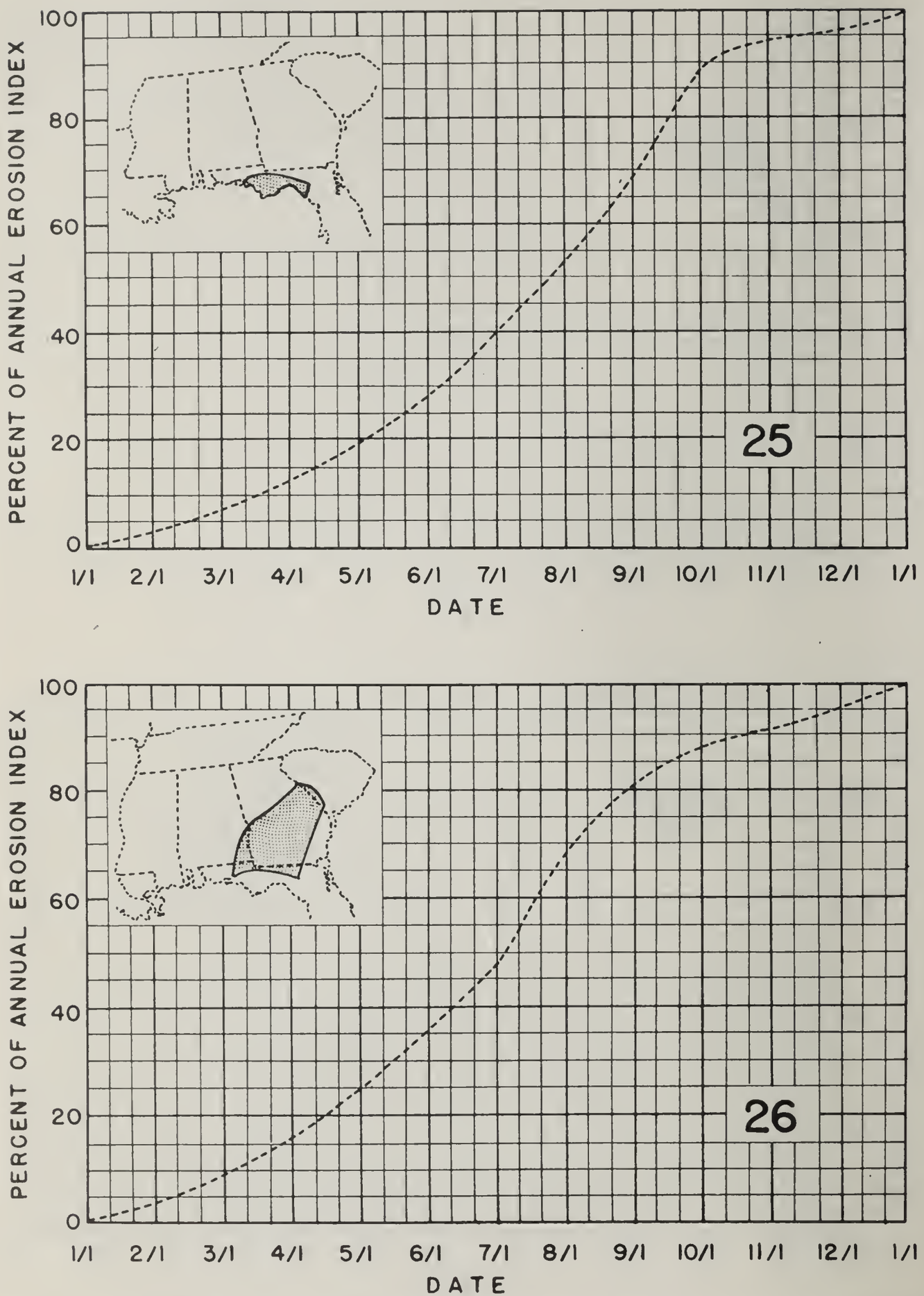
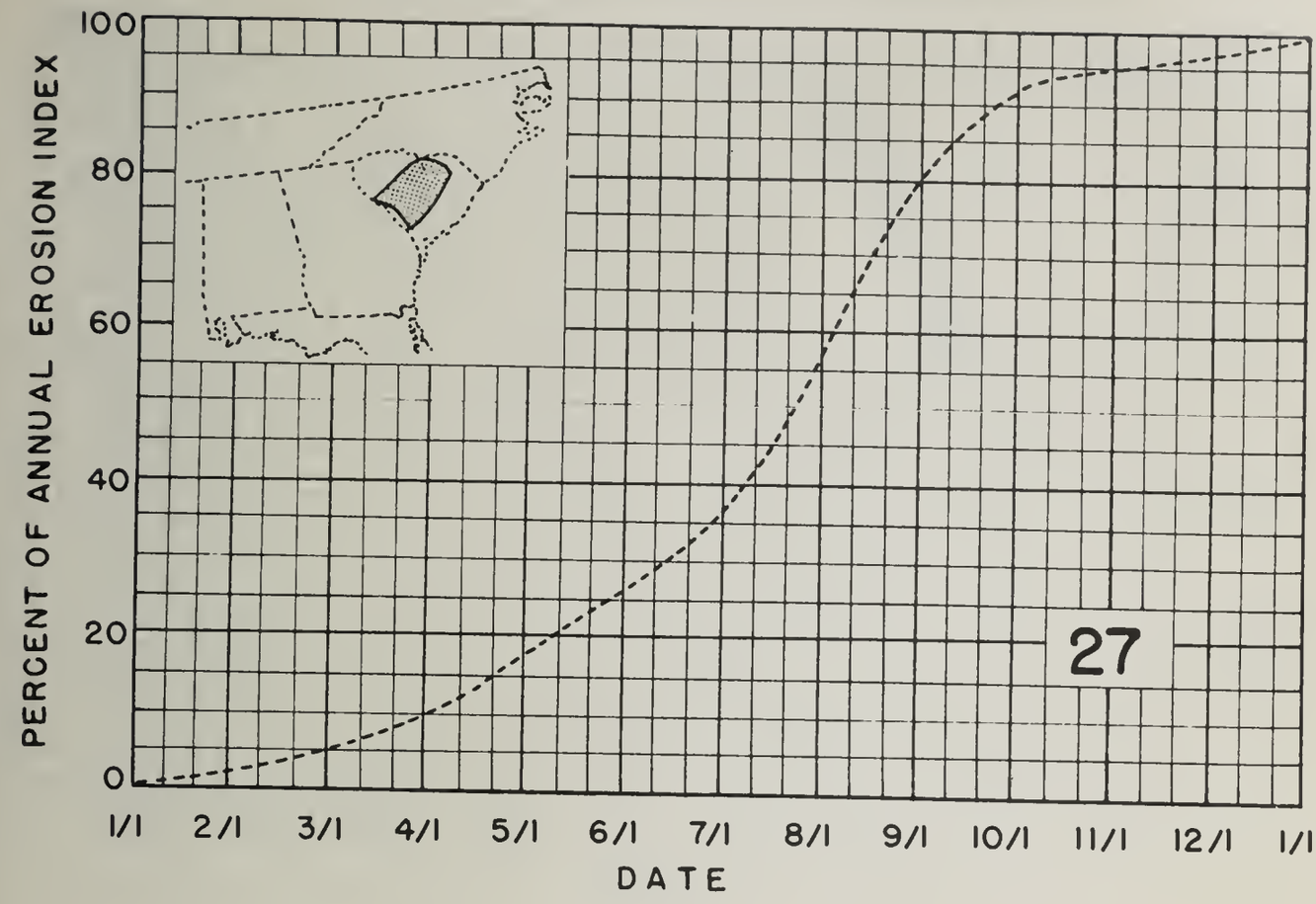


FIGURE 17.—Erosion-index distribution curves 25 and 26: parts of Florida and Georgia.



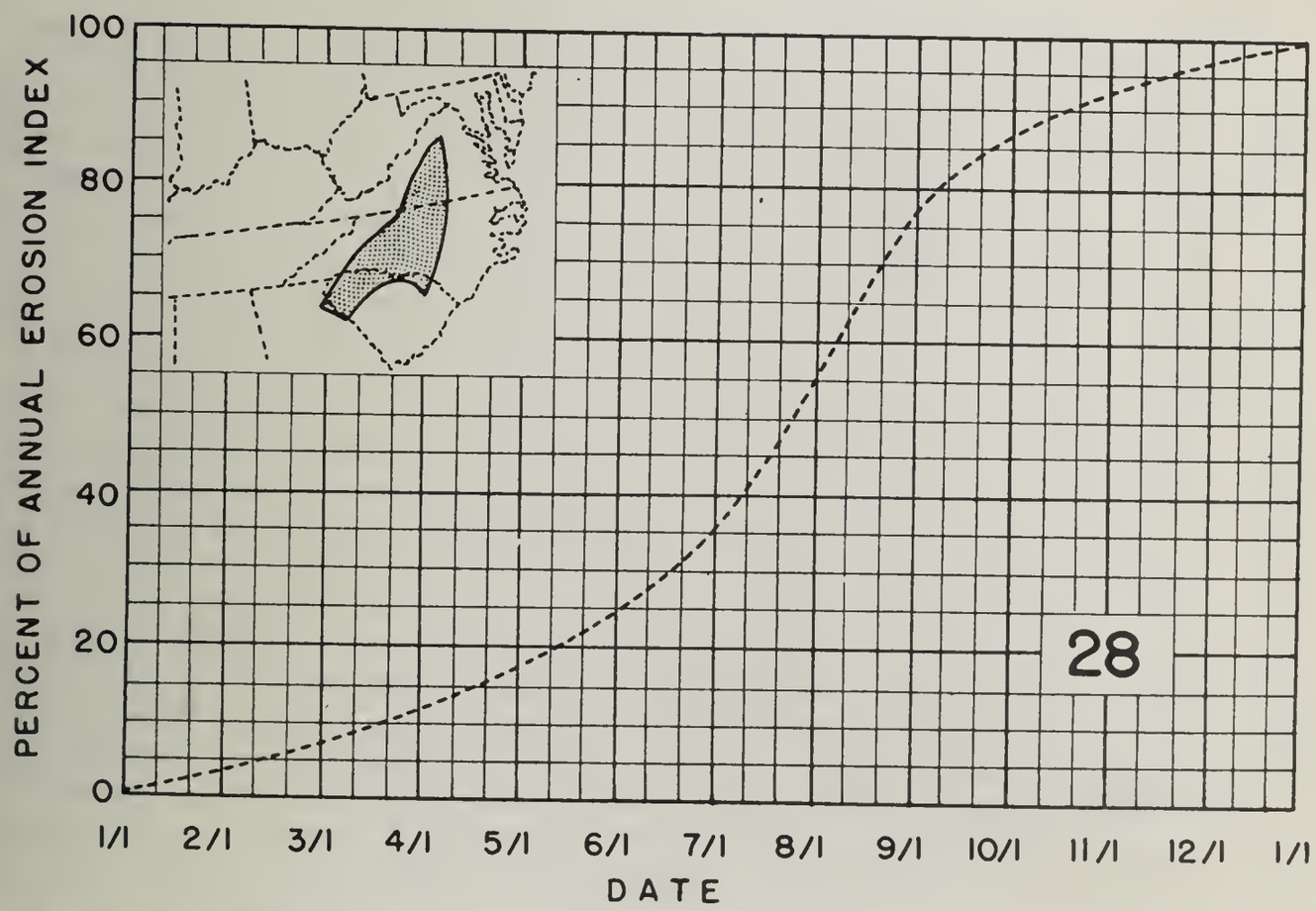
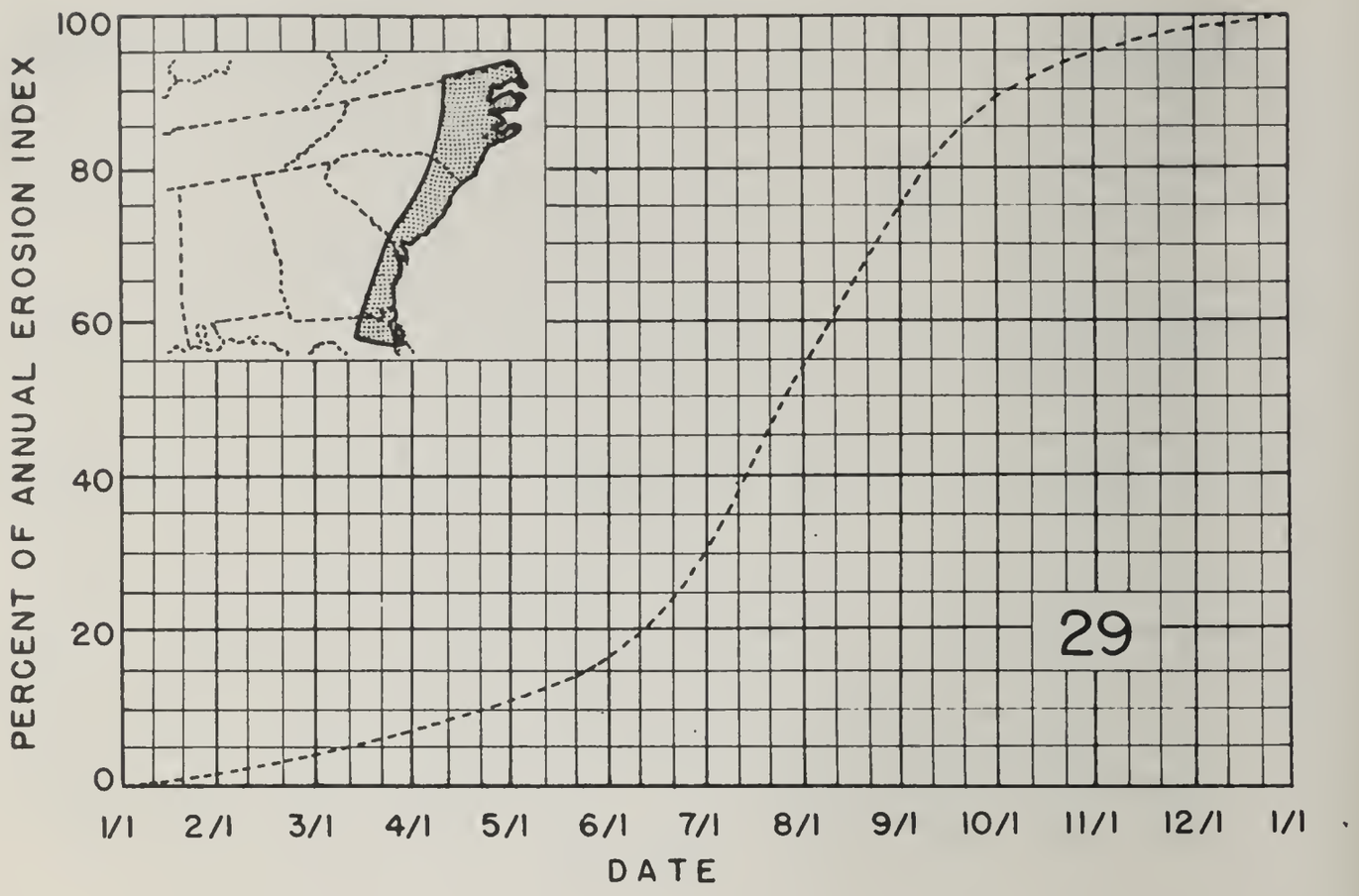


FIGURE 18.—Erosion-index distribution curves 27 and 28: parts of South Carolina, North Carolina, and Virginia.



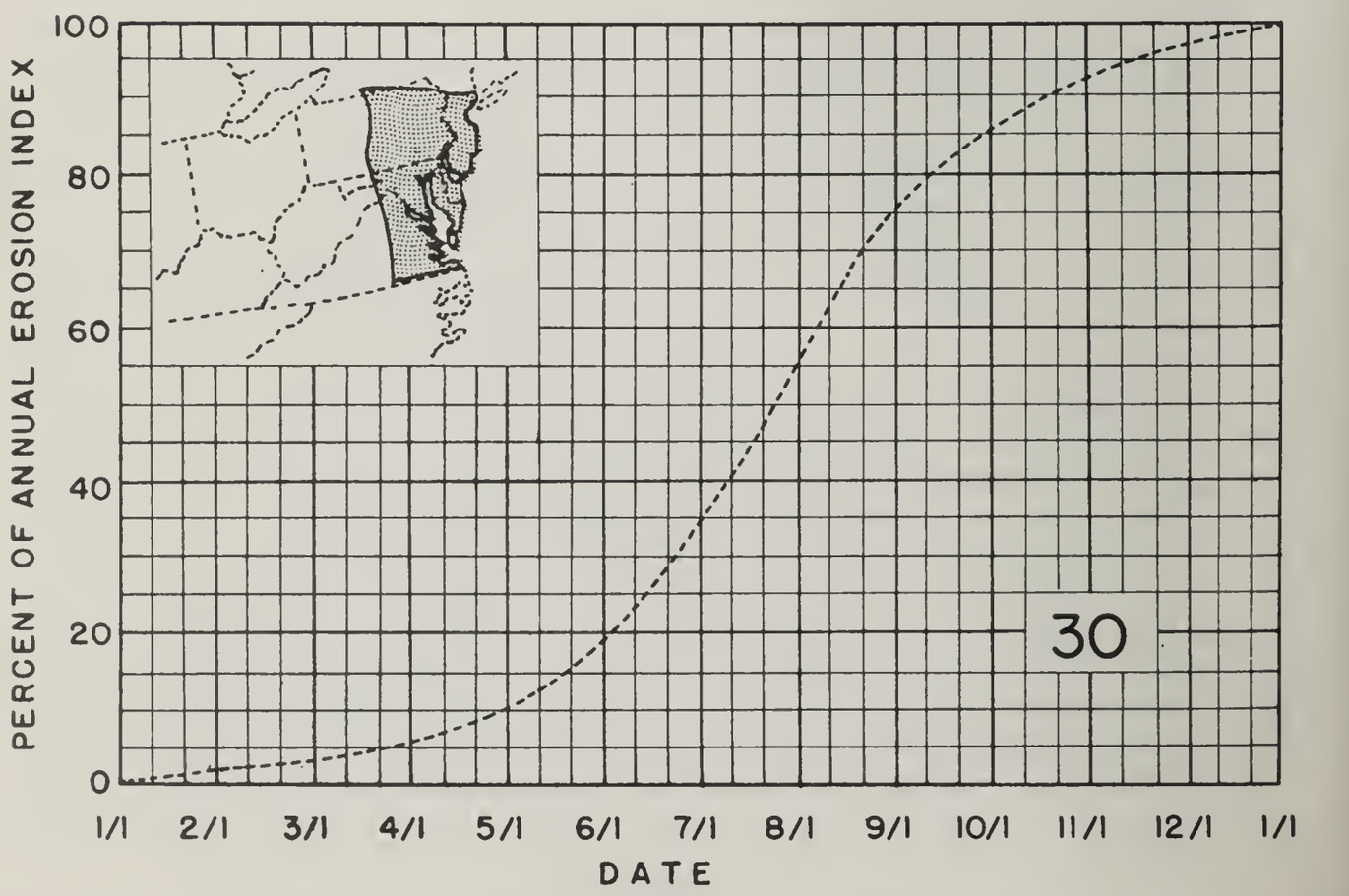
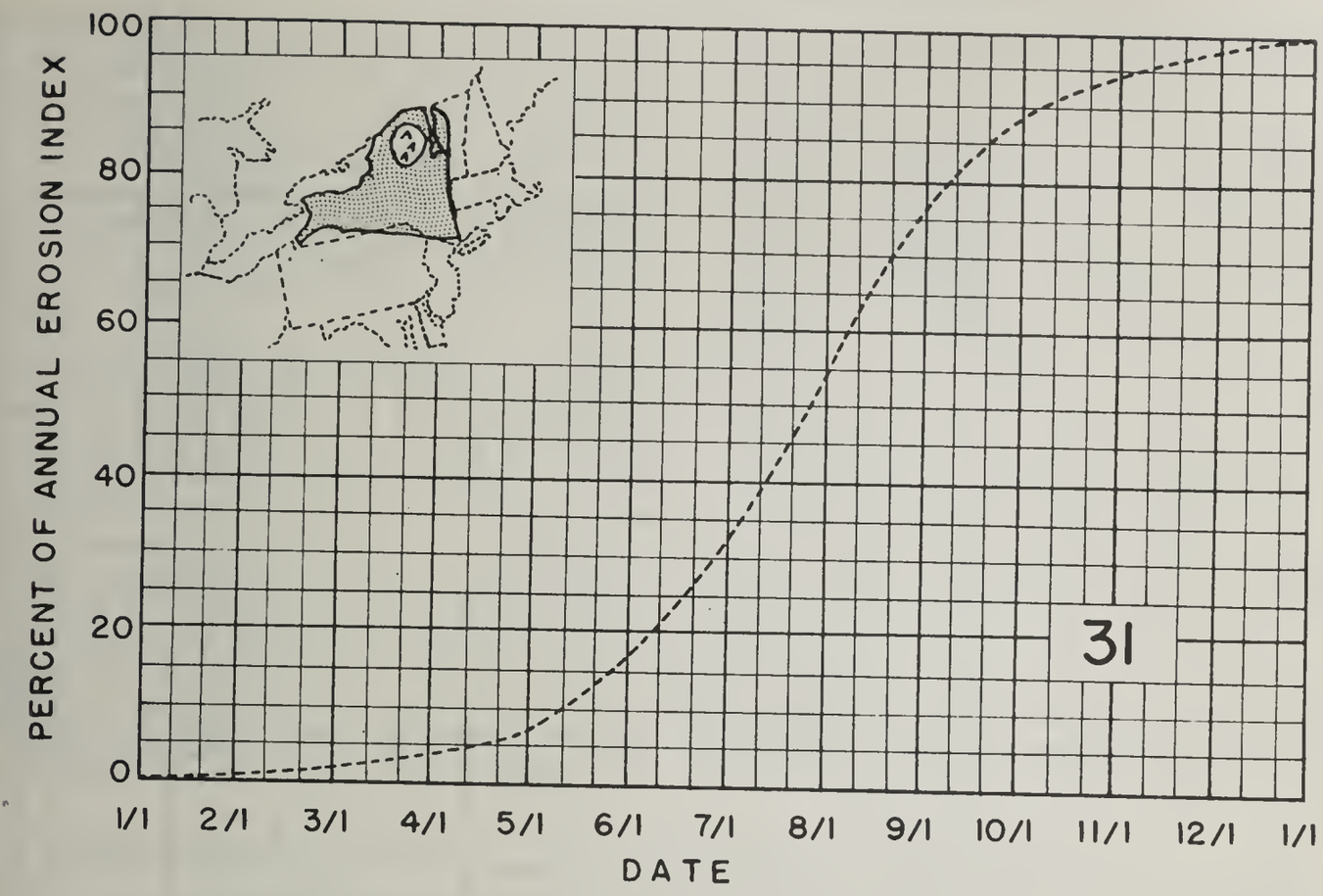


FIGURE 19.—Erosion-index distribution curves 29 and 30: Atlantic coast from New Jersey to Florida.



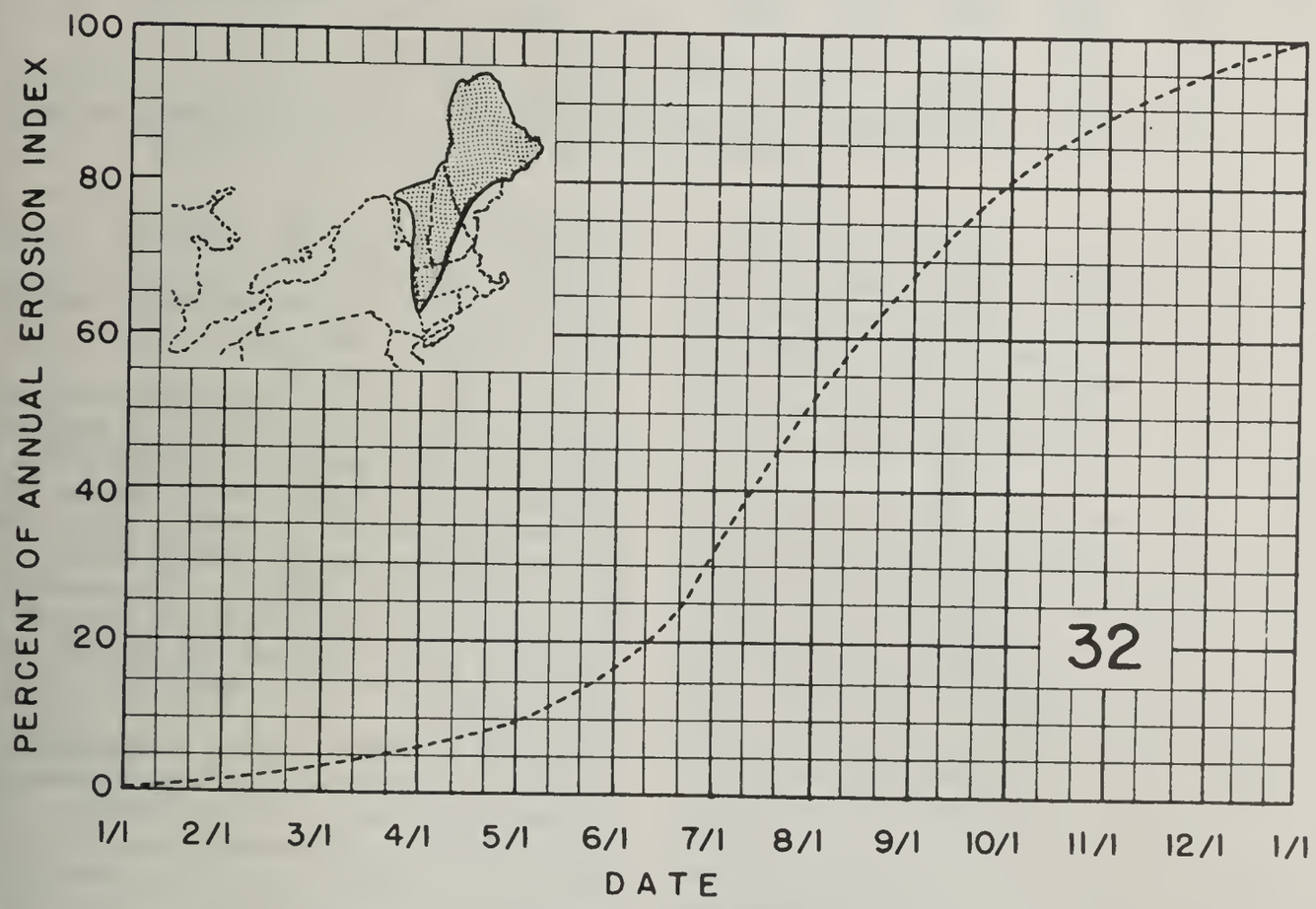


FIGURE 20.—Erosion-index distribution curves 31 and 32: New York and parts of Maine, New Hampshire, Vermont, and Massachusetts.

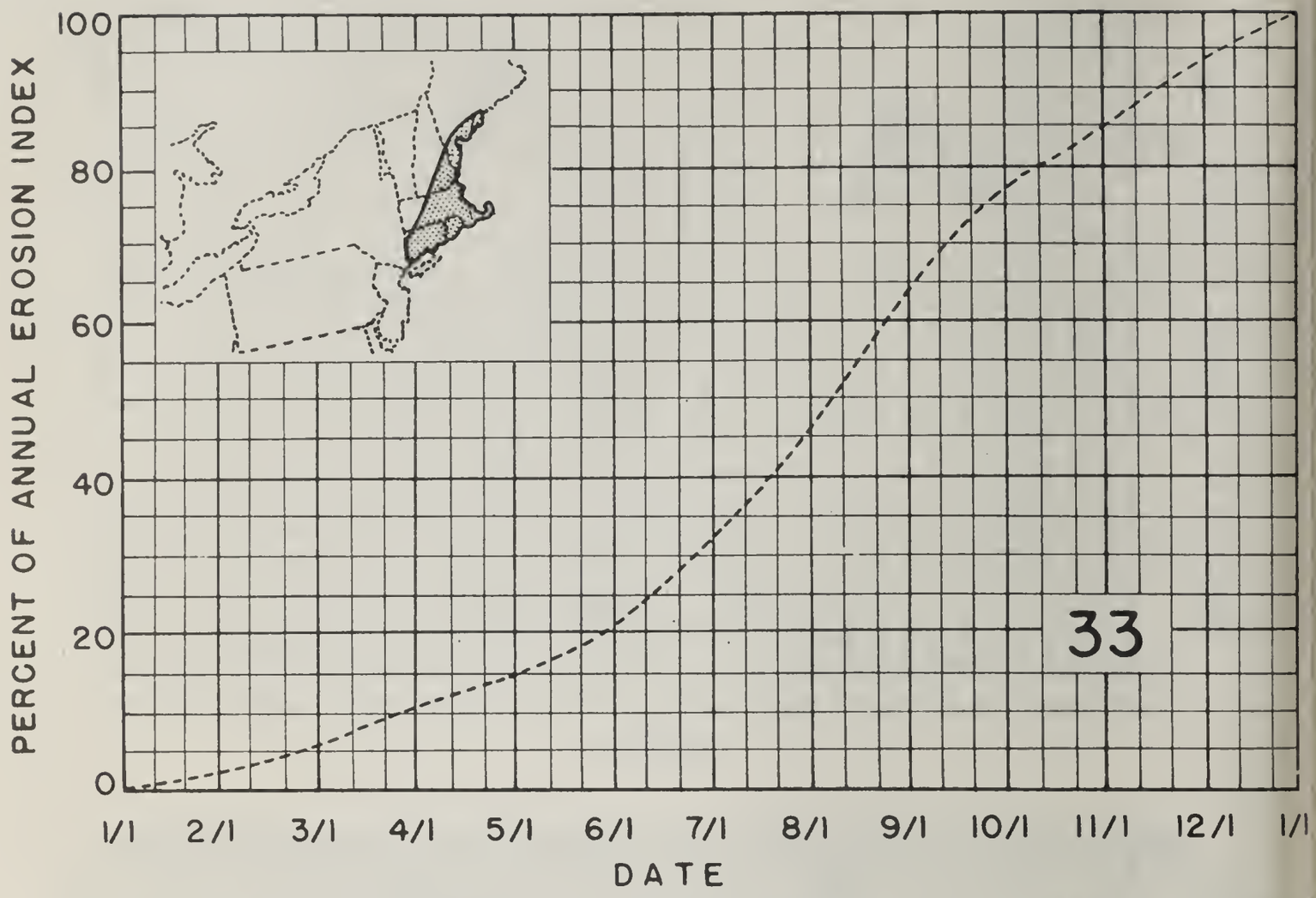


FIGURE 21.—Erosion-index distribution curve 33: Connecticut, Rhode Island and parts of Massachusetts, New Hampshire, and Maine.

method of seedbed preparation and residue management, and average crop yields including hay expected with this system on the soil involved and with the contemplated management. Tables 2 to 4 and figures 4 to 21 then supply the research data needed to complete the computation. The procedure will be explained by means of an example.

Problem.—Evaluate *C* for a 4-year rotation of wheat-with-meadow-seeding, meadow, corn, corn in central Indiana: (1) with conventional tillage and average production of 45 bushels of wheat, 4 tons of hay, and 100 bushels of corn per acre; (2) with minimum tillage and similar crop yields; and (3) with conventional tillage and yield averages of only 12 to 15 bushels of wheat, 2 tons of hay, and 40 to 55 bushels of corn. Assume that the meadow is a mixture of grass and legume, such as alfalfa and brome or timothy and clover; that crop residues are left on the field; that cornstalks are plowed under about May 1 for corn planting or disked for wheat seeding about October 10; and that wheat is harvested about July 10.

Procedure.—Set up a working table such as that illustrated in table 5, obtaining the needed information as follows:

Column 1 lists in chronological sequence all seeding and harvest dates (other than hay) involved in the rotation.

Column 2 lists the beginning date of each successive crop-stage period. A seeding date begins crop stage period 1. By definition, period 2 begins 1 month later, period 3 begins 2 months after seeding (except for winter grain), period 4 begins with crop harvest, and period F with the date of moldboard plowing. The meadow period begins 2 months after wheat harvest and extends to plowing date. Thus, all the dates in column 2 are determined by the locational seeding and harvest dates.

Column 3 records values read from the appropriate erosion-index distribution curve. Figure 4 shows that the curve applicable in central Indiana is No. 16. This curve appears in figure 12. The curve is read for each successive date listed in column 2, adding one to the "hundreds" column each time January 1 is passed.

Column 4 identifies the crop-stage period ending with the date shown on that line.

Column 5 lists the percentage of the erosion ndex applicable to each successive crop-stage ›eriod. The values are differences between uccessive curve readings recorded in column 3.

Column 6 lists the soil-loss ratio indicated in able 2, page 12, for the specific conditions and rop-stage period represented by each line in the vorking table. The numbers in parentheses ndicate the lines in table 2 from which the values vere taken.

The crop yield figure for entering table 2 is the xpected *average* yield, not the yield attainable in he most favorable years. If the likelihood of ieadow failure is significant, a yield figure well elow the expected average is appropriate. From n erosion viewpoint, the adverse effects of a ieadow failure in a rotation far outweigh the ains from occasional exceptionally good meadows.

All row-crop values in the table that are not herwise identified assume moldboard plowing, noothing for seedbed, and cultivation after nergence.

The *F* period precedes the crop year with which is associated in the table. For example, the value for rough fallow after first-year corn appears in the line for second-year corn.

Column 7 is self-explanatory. (The decimals in this column derive from the percentage values in columns 5 and 6.)

Column 8 subtotals for the different crops indicate where in the rotation most of the erosion is occurring and help to suggest where additional conservation measures could be most helpful in reducing erosion. The total for this column, divided by the number of years in the rotation, is the *C* value for this rotation under the conditions assumed in columns 1 to 6.

Columns 9 and 10 replace column 6 when solving parts 2 and 3 of the problem.

The first eight columns complete part 1 of the problem. Only the addition of columns 9 and 10 is needed to derive *C* values for the management levels specified in parts 2 and 3. Wheel-track planting (part 2) reduced the value of *C* from 0.119 to 0.075, a 37-percent reduction. A productivity level as low as that specified in part 3 would increase the *C* value for the rotation to 0.186, an increase of 56 percent. Expected

TABLE 5.—*Working table for derivation of C value for 4-year rotation in central Indiana*

(1) Operation	(2) Date	(3) Readings from curve No. 16	(4) Crop-stage period	(5) *EI* in period	(6) Soil-loss ratio [1] [2]	(7) Column 5 times col. 6	(8) Value of *C*	(9) Soil-loss ratio [2] [3]	(10) Soil-loss ratio [2] [4]
		Pct.		*Pct.*	*Pct.*			*Pct.*	*Pct.*
F W	10/10	91							
	11/10	96	W1	5	32(93)	0. 0160		32(93)	58(95)
F W	5/1	114	W2	18	19	. 0342		19	35
	7/10	153	W3	39	5	. 0195		5	15
	9/10	183	W4	30	3	. 0090	0. 0787	3	3
	9/10	283	M	100	. 4(122)	. 0040		. 4	. 6(121)
T	5/1	314	M	31	. 4	. 0012	. 0052	. 4	. 6
P C	5/20	321	F	7	8(1)	. 0056			15(5)
	6/20	339	C1	18	25	. 0450		8(8)	32
H C	7/20	359	C2	20	17	. 0340		8	30
T	10/15	392	C3	33	10	. 0330	. 1176	6	19
P C	5/1	414	C4	22	15	. 0330	. 0330	15	30
	5/20	421	F	7	25(13)	. 0175			42(16)
	6/20	439	C1	18	48	. 0864		25(19)	57
	7/20	459	C2	20	37	. 0740		25	49
P W	10/10	491	C3	32	20	. 0640	. 2419	12	28
Rotation total, 4 years				400			. 4764	[5] . 3005	[5] . 7438
Annual average *C* value for rotation							. 119	[6] . 075	[6] . 186

For 45 bu. wheat, 4 tons hay, 100 bu. corn per acre, o rentional seedbed and tillage.

Numbers in parentheses refer to line numbers in e 2.

Same yields as for column 6, except minimum tillage or he corn.

[4] For 12 to 15 bu. wheat, 2 tons hay, 40 to 55 bu. corn, conventional tillage.

[5] Sum of the products of *EI* increments (col. 5) and corresponding soil-loss ratios.

[6] Rotation total divided by number of years in the rotation.

soil loss from the field would be increased by the same percentage.

The C values computed for the rotation in the example are directly applicable only within area 16 of figure 4. For other areas or other seeding dates, the values in columns 3 and 5 of table 5 are different and the C value for the same rotation in other areas may be either larger or smaller.

It should be pointed out here that all these detailed computations are not required of each farm field. The procedure and basic data for derivation of the C values are provided primarily to enable computation of ready-reference handbook tables of values applicable in specific States or geographic areas. Knowledge of the procedure will, however, lead to a better understanding of the significance of such tables and will permit field computation of values for unusual situations.

The Erosion-Control Practice Factor (P)

In general, whenever sloping soil is to be cultivated and exposed to erosive rains, the protection offered by sod or close-growing crops in the system needs to be supported by practices that will slow the runoff water and thus reduce the amount of soil it can carry. The most important of these supporting practices for cropland are contour tillage, stripcropping on the contour, terrace systems, and stabilized waterways. The factor P in the erosion equation is the ratio of soil loss with the supporting practice to the soil loss with up-and-down-hill culture. Improved tillage practices, sod-based rotations, fertility treatments, and greater quantities of crop residues left on the field contribute materially to erosion control and frequently provide the major control in a farmer's field. However, these are considered conservation cropping and management practices, and the benefits derived from them are included in the factor C.

Contouring

The practice of tillage and planting on the contour have been, in general, effective in reducing erosion. In limited field studies, the practice provided almost complete protection against erosion from individual storms of moderate to low intensity, but it provided little or no protection against the occasional severe storms that caused extensive breakovers of the contoured rows. Contouring appears to produce its maximum average effect on slopes in the 3- to 7-percent range. As land slope decreases, it approaches equality with the contour row slope, and the soil-loss ratio approaches 1.0. As slope increases, contour row capacity decreases and the soil-loss ratio again approaches 1.0.

Practice-Factor Values for Contouring.—Afte available data and observations were considered a joint ARS–SCS–AES slope-practice worksho group meeting at Purdue University in 195 adopted the values of P shown in table 6.

TABLE 6.—*Practice factor values for contouring*

Land slope (percent)	P value
1.1 to 2	0. 6
2.1 to 7	. 5
7.1 to 12	. 6
12.1 to 18	. 8
18.1 to 24	. 9

These are average values for the factor. Lo cation values may vary with soil type, cropping residue management, and rainfall pattern.

The full benefits of contouring are obtained onl on fields relatively free from gullies and depres sions other than grassed waterways. The effec tiveness of this practice is reduced if a field con tains numerous small gullies and rills that are no obliterated by normal tillage operations. In such instances, land smoothing should be considered before contouring. Otherwise, a judgment valu greater than shown in table 6 should be used when computing the benefits for contouring.

Contour Listing.—Contour listing, with the corn planted in the furrows, has been more effective than surface planting on the contour (*8*). How ever, the additional effectiveness of this practice is limited to the time from the date of listing to that of the second corn cultivation. The soil-loss ratios (table 2) that apply to this period may be reduced 50 percent in addition to reduction supplied by the contour factor. The additional credit does not apply after the listed ridges have been largely obliterated by two corn cultivations.

A similar analysis would apply to commercial potato production where the potato rows are on the contour, except that in this case the 50-percent reduction would be applied only from lay by time to potato harvest.

Slope-Length Limits for Effective Contouring.— When rainfall exceeds infiltration and surface detention in large storms, breakovers of contour rows often result in concentrations of runoff that tend to become progressively greater with increases in slope length. Therefore, on slopes exceeding some critical length the amount of soil moved from a contoured field may approach or exceed that from a field on which each row carries its own runoff water down the slope. At what slope length this could be expected to occur would depend to some extent on gradient, soil properties, management, and storm characteristics. Terraces or the sod strips in a contour stripcrop system function to prevent serious

rosion damage when excessive row breakage ccurs.

After the 1956 slope-practice workshop, the oil Conservation Service prepared ready-refernce tables for use with the Corn Belt slope-ractice procedure. The values shown in table 7 ere given as guides to slope-length limits for ffective contouring. These are judgment values. esearch data are not now available to verify r correct them. It is important to bear in ind, however, that the contour factor values ven in table 6 assume slope lengths short ough for full effectiveness of the practice. Use these values for estimating soil loss on unter-ced slopes that are several terrace intervals in ngth is speculative.

TABLE 7.—*Length limits for contouring*

Slope (percent)	Maximum slope length
	Feet
2	400
4 to 6	300
8	200
10	100
12	80
18 to 24	60

Contour Stripcropping

Stripcropping, a practice in which contour ips of sod are alternated with strips of row p or small grain, has proved to be a more ective practice than contouring alone. A good mple is found in the Mormon Coulee near Crosse, Wis., where some fields are reported to ve been cropped in strips for more than 70 rs. Where the strips were on the contour, or rly so, good erosion control was accomplished. here the strips were 5 percent or more off tour, very high soil losses have occurred due the flow of runoff down the rows at high ocities.

Observations from stripcrop studies indicated t much of the soil washed from a cultivated p was filtered out of the runoff as it spread hin the first several feet of the adjacent sod p. Thus, the stripcrop factor, derived from -loss measurements at the foot of the slope, ounts for off-the-field movement of soil but for all movement within the field.

Practice Factor for Contour Stripcropping.—After review of available data and field observations, ARS–SCS Workshop group meeting at Pur- in 1956 decided to compute the contour-pcrop factor as one-half of that for contouring ne (table 6). This value was to apply with alternate grain-and-meadow strip system posible with a 4-year rotation of corn, small-grain, meadow, meadow, with the meadow established in the small grain. Strip guidelines were to be level. With less effective stripcrop systems, larger factor values are recommended.

With a cropping system such as a 4-year system of small grain, meadow, and 2 years of row crop, the contour factor value should probably be about 75 percent of the value in table 6 for contouring alone. Alternate strips of *fall*-seeded grain and row crop were effective on relatively flat slopes in Texas (*3*), but alternate strips of *spring*-seeded grain and corn on moderate to steep slopes have not appeared to provide significant erosion control benefits beyond those attained with contouring alone. For such systems the contour values are recommended.

Buffer stripcropping consists of narrow protective strips alternated with wide cultivated strips. The location of the protective strips is determined largely by the width and arrangement of adjoining strips to be cropped in the rotation and by the location of steep, severely eroded areas on slopes. Buffer strips usually occupy the correction areas on sloping land and are seeded to perennial grasses and legumes. This type of stripcropping is not so effective as contour stripcropping (*2*).

Width of Strips With Contour Stripcropping.—The strip widths shown in table 8 were recommended by the 1956 slope-practice workshop.

TABLE 8.—*Strip widths recommended for contours*

Slope group (percent)	Width of strip
	Feet
2 to 7	88 to 100
7 to 12	74 to 88
12 to 18	60 to 74
18 to 24	50 to 60

Terracing

Terracing with contour farming is more effective as an erosion-control practice than stripcropping, because it positively divides the slope into segments equal to the horizontal terrace spacing. With terracing, the slope length is this terrace interval; with stripcropping or contouring alone, it is the entire field slope length. Dividing a slope length into four equal segments cuts the expected rate of soil loss per acre in half. Dividing it into six equal segments divides the soil-loss rate by 2.45. These reductions are reflected in the erosion equation by changes in the *LS* factor value.

Both with terracing and with contour stripcropping, measured soil losses have included only soil moved completely off the field. The soil saved with contour stripcropping is largely that deposited in the sod strip. With terracing,

the deposit is in the terrace channel and may equal 90 percent of the soil moved to the channel (*28*). The slope-practice workshop group in 1956 decided to use neither the off-the-field soil-loss rate nor that for soil movement within the terrace interval, but a rate that shows a part of the soil deposited in the channels as not lost. The group recommended a terracing practice factor value equal to the one for contour strip-cropping.

If all furrow slices between the terraces were turned up slope periodically with a two-way plow, most or all of the soil washed into the terrace channel would be effectively moved back up the slope and a factor value based on the off-the-field rate of loss could be safely applied. Limited data indicate the terrace factor in this case should be about 20 percent of that for contouring. But in most farming operations, conventional plows are used and the soil deposited in the terrace channel is not returned to the interterrace interval to help maintain soil productivity.

It is logical to assume that the total movement of soil within a terrace interval is equal to that with contouring alone on the same length and percentage of slope. Erosion control between terraces depends upon the crop rotation and other management practices. Therefore, if a control level is desired that will maintain soil movement between terraces within the soil-loss tolerance limit, the practice factor for terracing should equal the contour practice factor.

However, if the erosion equation is used to compute gross erosion for estimates of reservoir sedimentation rates, a terracing practice factor equal to 20 percent of the contour factor values shown in table 6 is recommended. The reason for this lower value is that the soil deposited in the terrace channels, although lost from the terrace interval, does not leave the field completely to enter into the established drainageways.

Limitations

The rainfall-erosion index measures only the erosivity of rainfall and associated runoff. Therefore, the equation does not predict soil loss that is due solely to thaw, snowmelt, or wind. In areas where such losses are significant, they must be estimated separately and combined with those predicted by the equation for comparison with soil-loss tolerances.

FIELD APPLICATIONS OF THE SOIL-LOSS EQUATION

The primary purpose of the soil-loss prediction procedure described in this handbook is to provide specific and reliable guides to help select adequate soil and water conservation practices for farm fields. Where agricultural lands are a major sediment source, the procedure may also be used to compute this phase of sediment production in predicting rates of reservoir sedimentation. Specific applications of the erosion equation are discussed and illustrated below.

Predicting Field Soil Loss

Rotation Averages

The procedure for computing the expected average annual soil loss from a given cropping system on a particular field is illustrated by the following example.

Assume a field in Fountain County, Ind., on Russell silt loam, having an 8-percent slope about 200 feet long. The cropping system is a 4-year rotation of wheat, meadow, corn, corn with tillage and rows on the contour and with corn residues disked for wheat seeding and turned under in spring for second-year corn. Fertility and residue management on this farm are such that crop yields are rarely less than 85 bushels corn, 40 bushels wheat, or 4 tons alfalfa-brome hay, and the probability of meadow failure is slight.

The first step is to refer to the charts and tables discussed in the preceding section and to select the values of R, K, LS, C, and P that apply to the specific conditions on this particular field.

The value of the rainfall factor, R, is taken from figure 1, page 6. Fountain County, in west-central Indiana, lies between iso-erodents 175 and 200. By linear interpolation, $R=185$.

The value of the soil-erodibility factor, K, is taken from table 1, page 5, supplemented by K-value tables prepared at regional Soil-Loss Prediction Workshops.[6] Soil scientists in the North Central States consider Russell silt loam equal in erodibility to Fayette silt loam, for which table 1 lists $K=0.38$.

The slope-effect chart (fig. 2, p. 8), shows that, for an 8-percent slope, 200 feet long, $LS=1.41$.

Figure 4 (p. 17), shows that Fountain County is within the geographic area to which erosion-index distribution curve No. 16 applies. Using curve No. 16, figure 12, and soil-loss ratios taken from table 2 (p. 12) or table 4 (p. 16), compute the C value for the rotation by the procedure illustrated in table 5 (p. 35). For the productivity level and management practices assumed in this example, factor C for a W–M–C–C rotation in area 16 was shown in table 5 to equal 0.119.

Table 6 (p. 36) shows a practice-factor value of 0.6 for contouring on 8-percent slope, and table 7

[6] See footnote 3, p. 2.

(p. 37) indicates that the 200-foot slope is not too long for this factor to be applicable. Therefore, under the conditions assumed in this example, $P=0.6$.

The next step is to substitute the selected numerical values for the symbols in the erosion equation and solve for A. In this example, $A=185\times0.38\times1.41\times0.119\times0.6=7.1$ tons of soil loss per acre per year.

If planting had been up and down slope, instead of on the contour, the factor P would have equaled 1.0, and the predicted soil loss for this field would have been $185\times0.38\times1.41\times0.119\times1.0=11.8$ tons per acre.

Had contour farming been combined with minimum tillage for all corn in the rotation, the value of the factor C would have been 0.075 (see table 5). The predicted average annual soil loss from the field would then have been $185\times0.38\times1.41\times0.075\times0.6=4.5$ tons per acre.

Crop-Year Averages

The soil losses computed in the example are rotation averages over a long time period. Thus, the heavier losses experienced during the corn years are diluted by trivial losses during the meadow year. Please refer again to the first solution above, in which the rotation average was 7.1 tons per acre per year. The 4-year loss from each complete rotation cycle would average 4×7.1, or about 28.4 tons per acre.

Use of the values in column 8 of table 5 enables one to compute the average soil loss for each of the four crop years. Column 8 shows a computed C value of 0.0787 for the wheat period and a C of 0.4764 for the entire 4-year period. The average yearly soil loss from wheat in the above example, with contouring, would be $28.4\times0.079/0.476$, or 4.7 tons per acre. First-year corn, including the winter period, would average $28.4\times0.151/0.476$, or 9.0 tons. The second-year corn would average $28.4\times0.242/0.476$, or 14.4 tons, and the 20-month meadow period would average less than 0.5-ton soil loss per acre.

Soil-Loss Probabilities Other Than Average

Because rainfall differs from year to year, the actual value of the factor R also differs from year to year at any given location. Appendix table 11 lists 50-, 20-, and 5-percent probability values of R at 181 key locations. These may be used for further characterization of soil-loss hazards. Fountain, County, Ind. (where our example was located), is not listed in the table, but figure 1 shows that the R value there is essentially the same as the R value at Indianapolis. Table 11 shows that, over a long period, the value of the factor R will equal or exceed 225 at Indianapolis in 20 percent of the years. This is $225\div185$, or 1.22 times the average value. Returning once more to the example, soil loss from second-year corn on the assumed field would be expected to exceed $1.22\times14.4=17.6$ tons per acre in 20 percent of the years. The 5-percent probability value of R at Indianapolis is shown in table 11 to be 302, or 1.63 times the average value of 185. Therefore, soil loss from the second-year corn on the field assumed for our example would be expected to exceed $1.63\times14.4=23.5$ tons per acre in 5 percent of the years if the corn is contoured. Without contouring it would exceed $23.5\div0.6=39.2$ tons per acre in 5 percent of the years.

Individual-Storm Soil Losses

The assembled plot data show conclusively that the relation of soil loss to such major factors as slope, cropping, management, and conservation practices is not the same from storm to storm or from year to year, even on the same field under a continuing rotation. In a particular rainstorm, the factor relations are influenced by such variables as antecedent moisture, tillage, tractor and implement compaction, soil crusting by prior rains, and progressive changes in plant cover. Daily soil moisture and temperatures are more favorable to rapid development of good protective cover in some years than in others. The factor values reported in the preceding section and used in the foregoing examples represent average factor relations derived from research measurements over an extended period. Therefore, the erosion equation is particularly designed to predict average annual soil loss from any specific field over an extended period.

Predictions of individual-storm soil losses will be less accurate, because effects of the minor variations in antecedent conditions cannot be precisely evaluated at this time. However, valuable estimates of single-storm losses can be computed by the following procedure.

Instead of taking the value of R from figure 1, let R equal the computed erosion-index value for the specific rainstorm. Instead of the C value for the rotation, let C in the equation equal the soil-loss ratio shown in table 2, 3, or 4 for the specific conditions existing on the field at the time of the rain. For example, appendix table 12 shows that a 10-year rain at Indianapolis has an erosion-index value of 75 or more. Assume that such a rain occurred about 3 weeks after planting the second-year corn in the preceding example. The existing condition is then described by line 13 of table 2. Since the rain occurred within 30 days after corn planting, the value of C at the time of this particular rain is 48. The value of R is 75. Other values in the equation remain the same as in the first solution. The estimated soil loss from this single rainstorm on the second-year corn, without contouring, is then $R\cdot K\cdot L\cdot S\cdot C\cdot P=75\times0.38\times1.41\times0.48\times1.0=19.3$ tons per acre.

Specific-Year Soil Losses

Soil loss from a particular field in any specific year cannot presently be predicted in advance, primarily because it is not presently possible to predict the size and time of the rainstorms that will occur in that year. Deviations from average are very great. Surface conditions, quality of cover, and minor factors in tillage and management may also differ significantly from the average for that field. However, the erosion equation can provide reasonably reliable estimates of soil loss in a particular *past* year, if detailed rainfall records were obtained. Storm *EI* values need to be computed from the specific year's rainfall records, and the soil loss must be computed for each crop-stage period separately. This is done by letting R equal the erosion index measured for the crop-stage period and letting C equal the soil-loss ratio taken from table 2, as in the example for estimating individual-storm soil losses.

Even though a particular year's precipitation may have been essentially equal to the average annual rainfall in inches at that location, this fact is not justification for selecting R and C values from figure 1 and table 11 to estimate the soil loss for that particular year. Even with normal annual precipitation, the erosion index may have been well above or below normal because of abnormal intensities. The monthly distribution of the erosive rains may also have deviated significantly from normal.

Significance of Average Field Soil Loss

Knowledge of quantitative rates of erosion and soil-loss tolerances provides specific guidelines for effective erosion-control planning. Such values are, however, to be looked upon as guides that sometimes need to be tempered with judgment. It is important to bear in mind that the accepted expression for average rate of erosion from a field—tons of soil loss per acre—is not intended to imply uniform soil movement over the entire field area. Since soil loss increases as the 0.5 power of slope length, the erosion rate on the upper quarter of a field with a single uniform slope is about half the field average and that on the lower quarter is about 1½ times the field average. Because of the erodibility of the lower ends of long uniform or convex slopes, it may be appropriate to recommend subdividing such a slope even though the estimated average soil loss for the entire length is within the tolerance limit. On irregular topography, serious erosion may occur in some parts of a field while deposition occurs in others. In such cases, the erodible slopes need to be taken as the limiting factor for the field.

Determining Alternative Ways in Which a Particular Tract of Land May Be Used and Treated Successfully To Conserve or Improve It

The soil-loss prediction procedure provides the practicing conservationist with concise ready reference tables from which he can ascertain, for each particular situation encountered, which specific land use and management combination will provide the desired level of erosion control. A number of possible alternatives are usually indicated. From these, the farmer will be able to make a choice, in line with his desires and financial resources.

Management decisions generally influence erosion losses by affecting the factor C or P in the erosion equation. The factor L is modified only by terracing. The other three factors—R, K, and S—are essentially fixed so far as a particular field is concerned. When erosion is to be limited to the maximum allowable, or tolerance rate, the term A in the equation is replaced by T, and the equation is rewritten in the form: $CP=T/RKLS$. Substituting the locational values of the fixed factors in this equation and solving for CP give the maximum value that the product CP may assume under the specified field conditions. With no conservation practices, the most intensive cropping plan that can be safely used on the field is one for which the factor C just equals this value. When a conservation practice such as contouring or stripcropping is added, the computed value of $T/RKLS$ is divided by the practice factor, P, to obtain the maximum permissible cropping management factor value. With terracing, the value of $T/RKLS$ is increased by decreasing the value of L.

A special slide rule recently designed in Tennessee (*17*) enables rapid and systematic computation of $T/RKLS$ for any specific situation after pertinent values of the factors have been selected from the tables and charts.

Since a practicing conservationist usually works within the limits of a single county or other small geographic area, he will usually be concerned with only one value of R, one erosion-index distribution curve, K and T values for only a few soils, and C values for only a limited number of cropping systems. Therefore, the R value for his county, a list of T and K values for the soils in his work area, a few brief tables of pertinent $T/RKLS$ values, and a table of C values for pertinent rotations will provide all the information he will need to use this procedure as a guide to selection of conservation practices. He will rarely, if ever, need to solve the equation or to perform computations in the field.

The $T/RKLS$ values are the maximum allowable C values for the various soil and slope com-

binations in the conservationist's work area. They may be included in his handbook in the form illustrated by table 9, with a table for each major soil type with which he is concerned.

C values for rotations may be centrally computed for all cropping systems encountered within a given erosion-index distribution area (fig. 4), based on average seeding and harvest dates within that area. The factor for each cropping system needs to be computed for each of several crop-productivity levels and for each of several methods of residue management and seedbed preparation. The results are then listed in a table in order of declining magnitude of *C*, as illustrated in table 10.

To illustrate the selection process, we will assume a field in a county having a rainfall factor of 180, located within the erosion-index distribution area in which the *C* values of table 10 apply. Assume that the soil on this field has a *K* value of 0.33 and a soil-loss tolerance of 4 tons per acre per year. Past yields on the field have been from 2 to 3 tons hay and from 40 to 60 bushels corn per acre, with conventional seedbed preparation and tillage.

The land slope averages about 3 percent over the upper half of a total 400-foot slope, but the lower half steepens considerably and ranges from 5 to 7 percent. The field is planted as a single unit. In conservation farming, soil movement from the most vulnerable part of the field should be held below the tolerance limit, *T*. Therefore, the gradient of the lower half of the field is the significant percentage of slope for the soil loss estimate. However, surface runoff from the upper half passes over the lower half. Therefore, the overall length will be the effective slope length. Thus, a slope length of 400 feet and a slope gradient of 6 percent would be used to enter the ready-reference table.

For this soil and slope combination, table 9 lists a maximum *CP* value of 0.050. Entering table 10 with this value, the farmer finds that with straight rows and conventional tillage at the Y_2 yield level, the most intensive cropping system he can safely use is 1 year of corn in 5 years (C–O–M–M–M). Any system having a *C* value less than that for C–O–M–M–M should provide better than the tolerable level of erosion control under the conditions assumed for this example.

With contour farming, the maximum *C* value would be 0.10 (table 9), and he could move up the list in table 10 to a C–C–O–M–M–M system. Improvement in his general level of fertility and residue management would enable the farmer to use a more intensive cropping system safely or to attain a higher level of conservation, while at the same time increasing his crop yields. If he were able to reach and maintain average yields equal to Y_3 in table 10, he could move up to a C–O–M–M rotation without contouring or to C–C–O–M–M with contouring. If he then also added wheeltrack planting and minimum tillage for corn, he could move up the list to 2 years of corn and 1 year meadow in a C–C–O–M rotation. Thus, the tables, show the farmer how he can improve his erosion-control program and still increase yields or decrease labor and tractor costs.

A system of terraces would break the slope length and permit a higher degree of conservation or more intensive cropping systems. Terraces at about 100-foot horizontal intervals would reduce the effective slope length from 400 feet to 100 feet. For a 6-percent slope 100 feet long, contoured, table 9 shows a maximum *C* value of 0.20. This would permit any of the cropping systems listed in table 10 up to 3 years of corn in 5 (C–C–C–O–M) or a 2-year system of corn and oats with sweetclover intercrop. With wheeltrack planting, a 3-year rotation of corn, corn, oats-and-sweetclover would also appear satisfactory.

Estimating Source Sediment From Watersheds

Cultivated farm fields are a major sediment source in the general agricultural area of the humid and subhumid zones. The soil-loss prediction equation may be used effectively in making predictions of the magnitude of this sediment source. Other sources of sediment production that must be considered in making estimates of total sediment loads include gullies, roadside areas, and residential subdivisions.

The erosion equation provides a methodical means of bringing the effects of expected rainfall pattern, soil properties, and land use into computation of that part of the sediment production that is attributable to sheet and rill erosion. The drainage area may be broken down into a series of tracts having relatively homogeneous land use and treatment. The erosion equation is then used to approximate the average annual rate of soil movement from each tract.

However, sediment estimates computed in this manner are estimates of average annual sediment production over a period of at least 25 years or more. Gross erosion on the watershed in any one particular year may be at least three or four times this average rate. In other years it will be less. This is true for a number of reasons. Table 11 shows that in one year out of 20, the rainfall erosion index is at least twice the average for that location. At the same time, abnormal distribution of erosive rains may result in a greater than average portion of the erosive rainfall occurring when the fields are most vulnerable to rainfall erosion. Breakover of contour rows in a severe rainstorm may increase greatly the gross erosion from that storm and also from succeeding storms until the break is obliterated by tillage. Adverse

TABLE 9.—*Maximum permissible C values (T/RKLS) for indicated gradient and slope length with straight and with contoured rows for soil type with the K, T, and R values as listed*

For soil type with K=0.33, T=4 or K=0.25, T=3, and R=180.

Gradient (percent)	Values for slope length (in feet) of—							
	60	80	100	150	200	250	300	400
	STRAIGHT ROW							
2	0.45	0.35	0.33	0.26	0.22	0.20	0.17	0.15
4	.22	.19	.17	.13	.11	.10	.092	.081
6	.13	.11	.10	.083	.072	.065	.058	.050
8	.089	.077	.068	.055	.048	.043	.039	.034
10	.064	.056	.050	.040	.035	.030	.028	.024
12	.048	.042	.037	.030	.026	.023	.021	.018
14	.038	.033	.029	.024	.020	.018	.017	.014
16	.030	.026	.024	.019	.016	.015	.013	.012
18	.025	.022	.019	.016	.014	.012	----------	----------
20	.021	.018	.016	.013	.011	----------	----------	----------
	CONTOURED							
2	0.75	0.58	0.57	0.43	0.37	0.33	0.28	0.25
4	.44	.38	.34	.26	.22	.20	.18	0.16
6	.26	.22	.20	.17	.14	.13	.12	.10
8	.15	.13	.11	.092	.080	.072	.065	.057
10	.11	.093	.083	.067	.058	.050	.047	.040
12	.08	.070	.062	.050	.043	.038	.035	.030
14	.048	.041	.036	.030	.025	.022	.021	.018
16	.038	.032	.030	.024	.020	.019	.016	.015
18	.031	.027	.024	.020	.018	.015	----------	----------
20	.023	.020	.018	.014	.012	----------	----------	----------

weather in one year may cause widespread meadow failure within the watershed area. Gross erosion from the first-year and second-year rotation corn after a poor meadow will then be substantially greater than normal and may nearly equal that from continuous row cropping. Furthermore, one segment of the watershed may receive a severe rainstorm while another segment of the same watershed receives little or no rain. Location of the storm center will differ from one storm to another, so that the long-time average rainfall may be nearly uniform. However, specific-storm or specific-year values of both R and C may deviate a great deal from their average values for that location. When gross erosion is to be estimated for a specific short-term period for evaluation of sediment delivery rates, the specific EI value and soil-loss ratio for each successive crop-stage period must be used in lieu of the annual erosion index and the rotation C value. (Refer to page 39 for details.)

Correct interpretation of watershed conditions for selection of appropriate values of the factors L and S is also very important, but interpretation is frequently quite difficult because of complex topography. Complex soil and land use patterns superimposed upon a complex topography present problems in interpretation and factor evaluation that need further research analysis. However, the definition of slope length, page 9, and the discussion of convex and concave slopes, page 8, provide helpful guides. Slope shapes and drainage patterns need to be carefully considered. A steep gradient at the lower end of a slope should not be averaged with a gentle gradient at the upper end. A slope length does not terminate simply because of a wire fence or a change in cropping. If runoff from an area above a field is allowed to enter the field as sheet flow, the upper area is part of the slope length for computing erosion on the field. However, sufficient flattening of the slope to cause deposition to begin indicates the end of a slope length.

The sum of the estimates for the individual tracts making up the watershed approximates the quantity of soil moved from its original general position. This initial sediment estimate must be adjusted downward to compensate for deposition in terrace channels, in sod waterways, in field boundaries, and at the toe of field slopes. Further changes in sediment content of runoff water will occur during the stream transport phase.

The appropriate value of the factor P for a terraced field is considerably lower for purposes

TABLE 10.—*Partial list of C values for common rotations for a specific erosion-index distribution area* [1]

Cropping system [2]		*C* values for RdL, disked for small grain, spring-plowed for corn				
		Conventional plant and till [4]			Minimum tillage [4]	
Rotations	Limits [3]	Y_1	Y_2	Y_3	Y_2	Y_3
ontinuous corn		0. 48	0. 43	0. 38	0. 33	0. 27
-C-C-O_x		. 36	. 31	. 27	. 23	. 19
-C-O_x		. 32	. 27	. 24	. 19	. 17
-C-C-O-M		. 25	. 20	. 19	. 14	. 12
-O_x		. 25	. 18	. 17	. 13	. 12
-C-O-M	*c*	. 19	. 14	. 12	. 10	. 082
-C-O-M-M		. 15	. 12	. 10	. 081	. 066
-C-O-M-M-M		. 13	. 096	. 082	. 068	. 057
-O-W-M		. 13	. 083	. 058	. 064	. 049
-O-M		. 12	. 079	. 058	. 052	. 037
-O-M-M	*b*	. 088	. 060	. 045	. 040	. 029
-O-M-M-M		. 071	. 049	. 036	. 033	. 024
-O-M-M-M-M		. 060	. 042	. 031	. 028	. 020
	a					

[1] Area shown in fig. 12 for curve No. 16.

[2] Abbreviations: C—corn, O—oats, O_x—oats with sweet clover intercrop, W—fall-seeded grain, M—grass and legume meadow, RdL—residues left.

Dashed lines indicate cropping system limits for: *a*, straight-row farming; *b*, contouring; *c*, terraces. Acceptable rotations are those below the lines.

[4] Y_1—average yields of 1 to 2 tons hay, 40 to 59 bu. corn.
Y_2—average yields of 2 to 3 tons hay, 60 to 74 bu. corn.
Y_3—average yields of 3 to 5 tons hay, 75 to 100 bu. corn.

o watershed sediment prediction than it is for prposes of erosion-control planning. As much a 90 percent of the soil eroded from the area b;ween terraces may be deposited in the channels (3). For sediment prediction, the important nsideration is the quantity of soil moved com- o tely *off* the field. For this purpose, *P* values ual to about 20 percent of the contour practice ues shown in table 6 are recommended.

When runoff from a cropped field enters a grass waterway or crosses a sodded fence row or streambank area to enter a main drainageway, part of the silt load is filtered out by the sod, as it is in a cultivated field with contour stripcropping. If the gradient decreases significantly between the lower end of the cropped field and the point where the runoff enters the drainageway, deposition may occur even if the area is not sodded. Factors to adjust gross-erosion estimates for these situations have not been evaluated.

SUMMARY

The soil-loss prediction procedure presented n this handbook provides a methodical means o using all available research information to e guide land use and management decisions r any particular farm field where soil erosion rainfall and runoff is a problem. The soil- prediction equation presented is universally plicable wherever locational values of the uation's individual factors are known or can edetermined. Research data assembled from llmajor agricultural areas of the United States te analyzed and summarized in ready-reference tables and graphs. These provide a source of information for approximating the factor values needed to apply the equation to the specific conditions in the various geographic areas.

Data and procedures are presented in considerable detail, to help the user interpret the guides supplied by solutions of the equation. Applications of the procedures are illustrated in specific examples.

Use of the equation, tables, and figures for predicting soil erosion losses on any particular

field, under each of various alternative cropping systems and management practices, is not a complicated procedure. Comparison of the predicted erosion rates with the applicable soil-loss tolerance provides very specific guidelines for effecting erosion control within specified limits. For the selection of practices on an individual farm, the procedure can be reduced to use of a few reference tables derived for the particular geographic area.

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APPENDIX

TABLE 11.—*Observed range and 5-, 20-, and 50-percent probability values of erosion index at each of 181 key locations*

Location	Values of erosion index (*EI*)			
	Observed 22-year range	50-percent probability	20-percent probability	5-percent probability
Alabama:				
Birmingham	179–601	354	461	592
Mobile	279–925	673	799	940
Montgomery	164–780	359	482	638
Arkansas:				
Fort Smith	116–818	254	400	614
Little Rock	103–625	308	422	569
Mountain Home	98–441	206	301	432
Texarkana	137–664	325	445	600
California:				
Red Bluff	11–240	54	98	171
San Luis Obispo	5–147	43	70	113
Colorado:				
Akron	8–247	72	129	225
Pueblo	5–291	44	93	189
Springfield	4–246	79	138	233
Connecticut:				
Hartford	65–355	133	188	263
New Haven	66–373	157	222	310
District of Columbia	84–334	183	250	336
Florida:				
Apalachicola	271–944	529	663	820
Jacksonville	283–900	540	693	875
Miami	197–1225	529	784	1136
Georgia:				
Atlanta	116–549	286	377	488
Augusta	148–476	229	308	408
Columbus	215–514	336	400	473
Macon	117–493	282	357	447
Savannah	197–886	412	571	780
Watkinsville [1]	182–544	278	352	441
Illinois:				
Cairo	126–575	231	349	518
Chicago	50–379	140	212	315
Dixon Springs [1]	89–581	225	326	465
Moline	80–369	158	221	303
Rantoul	73–286	152	201	263
Springfield	38–315	154	210	283
Indiana:				
Evansville	104–417	188	263	362
Fort Wayne	60–275	127	183	259
Indianapolis	60–349	166	225	302
South Bend	43–374	137	204	298
Terre Haute	81–413	190	273	389
Iowa:				
Burlington	65–286	162	216	284
Charles City	39–308	140	205	295
Clarinda [1]	75–376	162	220	295
Des Moines	30–319	136	198	284
Dubuque	54–389	175	251	356
Sioux City	56–336	135	205	308
Rockwell City	40–391	137	216	335
Kansas:				
Burlingame	57–447	176	267	398
Coffeyville	66–546	234	339	483
Concordia	38–569	131	241	427
Dodge City	16–421	98	175	303
Goodland	10–166	76	115	171
Hays [1]	66–373	116	182	279
Wichita	42–440	188	292	445
Kentucky:				
Lexington	54–396	178	248	340
Louisville	84–296	168	221	286
Middlesboro	107–301	154	197	248
Louisiana:				
Lake Charles	200–1019	572	786	1063
New Orleans	273–1366	721	1007	1384
Shreveport	143–707	321	445	609
Maine:				
Caribou	26–120	58	79	106
Portland	36–241	91	131	186
Skowhegan	39–149	78	108	148
Maryland, Baltimore	50–388	178	263	381
Massachusetts:				
Boston	39–366	99	159	252
Washington	65–229	116	153	198
Michigan:				
Alpena	14–124	57	85	124
Detroit	56–179	100	134	177
East Lansing	35–161	86	121	166
Grand Rapids	33–203	84	123	178
Minnesota:				
Alexandria	33–301	88	147	240
Duluth	7–227	84	127	189
Fosston	22–205	62	108	184
Minneapolis	19–173	94	135	190
Rochester	46–338	142	207	297
Springfield	37–290	96	154	243
Mississippi:				
Meridian	216–820	416	557	737
Oxford	131–570	310	413	543
Vicksburg	165–786	365	493	658
Missouri:				
Columbia	98–419	214	297	406
Kansas City	28–361	170	248	356
McCredie [1]	64–410	189	271	383
Rolla	105–415	209	287	387
Springfield	97–333	199	266	352
St. Joseph	50–359	178	257	366
St. Louis	59–737	168	290	488
Montana:				
Billings	2–82	12	26	50
Great Falls	3–62	13	24	44
Miles City	1–101	21	40	72
Nebraska:				
Antioch	18–131	60	86	120
Lincoln	44–289	133	201	299
Lynch	34–217	96	142	205
North Platte	14–236	81	136	224
Scribner	69–312	154	205	269
Valentine	4–169	64	100	153
New Hampshire, Concord	52–212	91	131	187
New Jersey:				
Atlantic City	71–318	166	229	311
Marlboro [1]	58–331	186	254	343
Trenton	37–382	149	216	308
New Mexico:				
Albuquerque	0–46	10	19	35
Roswell	5–159	41	73	128
New York:				
Albany	40–172	81	114	159
Binghamton	20–151	76	106	146
Buffalo	20–148	66	96	139
Geneva [1]	33–180	73	106	152
Marcellus [1]	24–241	74	112	167
Rochester	22–180	66	101	151
Salamanca	31–202	70	106	157
Syracuse	8–219	83	129	197
North Carolina:				
Asheville	76–238	135	175	223
Charlotte	113–526	229	322	443
Greensboro	102–357	184	244	320
Raleigh	152–569	280	379	506
Wilmington	196–701	358	497	677
North Dakota:				
Bismarck	9–189	43	73	120
Devils Lake	21–171	56	90	142
Fargo	5–213	62	113	200
Williston	4–71	30	45	67
Ohio:				
Cincinnati	66–352	146	211	299
Cleveland	21–186	93	132	185
Columbiana	29–188	96	129	173
Columbus	45–228	113	158	216
Coshocton [1]	72–426	158	235	343
Dayton	56–245	125	175	240
Toledo	32–189	83	120	170
Oklahoma:				
Ardmore	100–678	263	395	582
Cherokee [1]	49–320	167	242	345
Guthrie [1]	69–441	210	316	467
McAlester	105–741	272	411	609
Tulsa	19–584	247	347	478
Oregon:				
Pendleton	2–28	4	8	16
Portland	16–80	40	56	77
Pennsylvania:				
Erie	11–534	96	181	331
Franklin	50–228	97	135	184
Harrisburg	48–232	105	146	199
Philadelphia	72–361	156	210	282

See footnote at end of table.

TABLE 11.—*Observed range and 5-, 20-, and 50-percent probability value of erosion index at each of 181 key locations*—Continued

Location	Values of erosion index (*EI*)			
	Observed 22-year range	50-percent probability	20-percent probability	5-percent probability
Pennsylvania—Con.				
Pittsburgh	43–201	111	148	194
Reading	84–308	144	204	285
Scranton	52–198	104	140	188
Puerto Rico, San Juan	203–577	345	445	565
Rhode Island, Providence	53–225	119	167	232
South Carolina:				
Charleston	174–1037	387	559	795
Clemson [1]	138–624	280	384	519
Columbia	81–461	213	298	410
Greenville	130–589	249	350	487
South Dakota:				
Aberdeen	19–295	74	129	219
Huron	18–145	60	91	136
Isabel	16–141	48	78	125
Rapid City	10–140	37	64	108
Tennessee:				
Chattanooga	163–468	269	348	445
Knoxville	64–370	173	239	325
Memphis	139–595	272	384	536
Nashville	116–381	198	262	339
Texas:				
Abilene	27–554	146	253	427
Amarillo	33–340	110	184	299
Austin	59–669	270	414	624
Brownsville	46–552	267	386	549
Corpus Christi	124–559	237	330	451
Dallas	93–630	263	396	586
Del Rio	19–405	121	216	374
El Paso	4–85	18	36	67
Houston	176–1171	444	674	1003
Lubbock	17–415	82	158	295
Midland	35–260	82	139	228
Nacogdoches	153–769	401	571	801
San Antonio	77–635	220	353	556
Temple [1]	81–644	261	379	542
Victoria	108–609	265	385	551
Wichita Falls	79–558	196	298	447
Vermont, Burlington	33–270	72	114	178
Virginia:				
Blacksburg [1]	81–245	126	168	221
Lynchburg	64–366	164	232	324
Richmond	102–373	208	275	361
Roanoke	78–283	129	176	237
Washington:				
Pullman [1]	1–30	6	12	21
Spokane	1–19	7	11	17
West Virginia:				
Elkins	43–223	118	158	209
Huntington	56–228	127	173	233
Parkersburg	69–303	120	165	226
Wisconsin:				
Green Bay	17–148	77	107	147
LaCrosse [1]	61–385	153	228	331
Madison	38–251	118	171	245
Milwaukee	31–193	93	139	202
Rice Lake	24–334	122	202	327
Wyoming:				
Casper	1–24	9	15	26
Cheyenne	8–66	28	43	66

[1] Computations based on ARS-SWC rainfall records. All others are based on Weather Bureau records.

TABLE 12.—*Expected magnitudes of single-storm erosion index values*

Location	Index values normally exceeded once in—				
	1 year	2 years	5 years	10 years	20 years
Alabama:					
Birmingham	54	77	110	140	170
Mobile	97	122	151	172	194
Montgomery	62	86	118	145	172
Arkansas:					
Fort Smith	43	65	101	132	167
Little Rock	41	69	115	158	211
Mountain Home	33	46	68	87	105
Texarkana	51	73	105	132	163
California:					
Red Bluff	13	21	36	49	65
San Luis Obispo	11	15	22	28	34
Colorado:					
Akron	22	36	63	87	118
Pueblo	17	31	60	88	127
Springfield	31	51	84	112	152
Connecticut:					
Hartford	23	33	50	64	79
New Haven	31	47	73	96	122
District of Columbia	39	57	86	108	136
Florida:					
Apalachicola	87	124	180	224	272
Jacksonville	92	123	166	201	236
Miami	93	134	200	253	308
Georgia:					
Atlanta	49	67	92	112	134
Augusta	34	50	74	94	118
Columbus	61	81	108	131	152
Macon	53	72	99	122	146
Savannah	82	128	203	272	358
Watkinsville	52	71	98	120	142
Illinois:					
Cairo	39	63	101	135	173
Chicago	33	49	77	101	129
Dixon Springs	39	56	82	105	130
Moline	39	59	89	116	145
Rantoul	27	39	56	69	82
Springfield	36	52	75	94	117
Indiana:					
Evansville	26	38	56	71	86
Fort Wayne	24	33	45	56	65
Indianapolis	29	41	60	75	90
South Bend	26	41	65	86	111
Terre Haute	42	57	78	96	113
Iowa:					
Burlington	37	48	62	72	81
Charles City	33	47	68	85	103
Clarinda	35	48	66	79	94
Des Moines	31	45	67	86	105
Dubuque	43	63	91	114	140
Rockwell City	31	49	76	101	129
Sioux City	40	58	84	105	131
Kansas:					
Burlingame	37	51	69	83	100
Coffeyville	47	69	101	128	159
Concordia	33	53	86	116	154
Dodge City	31	47	76	97	124
Goodland	26	37	53	67	80
Hays	35	51	76	97	121
Wichita	41	61	93	121	150
Kentucky:					
Lexington	28	46	80	114	151
Louisville	31	43	59	72	85
Middlesboro	28	38	52	63	73
Louisiana:					
New Orleans	104	149	214	270	330
Shreveport	55	73	99	121	141

TABLE 12.—*Expected magnitudes of single-storm erosion index values*—Continued

Location	Index values normally exceeded once in—				
	1 year	2 years	5 years	10 years	20 years
Maine:					
Caribou	14	20	28	36	44
Portland	16	27	48	66	88
Skowhegan	18	27	40	51	63
Maryland, Baltimore	41	59	86	109	133
Massachusetts:					
Boston	17	27	43	57	73
Washington	29	35	41	45	50
Michigan:					
Alpena	14	21	32	41	50
Detroit	21	31	45	56	68
East Lansing	19	26	36	43	51
Grand Rapids	24	28	34	38	42
Minnesota:					
Duluth	21	34	53	72	93
Fosston	17	26	39	51	63
Minneapolis	25	35	51	65	78
Rochester	41	58	85	105	129
Springfield	24	37	60	80	102
Mississippi:					
Meridian	69	92	125	151	176
Oxford	48	64	86	103	120
Vicksburg	57	78	111	136	161
Missouri:					
Columbia	43	58	77	93	107
Kansas City	30	43	63	78	93
McCredie	35	55	89	117	151
Rolla	43	63	91	115	140
Springfield	37	51	70	87	102
St. Joseph	45	62	86	106	126
Montana:					
Great Falls	4	8	14	20	26
Miles City	7	12	21	29	38
Nebraska:					
Antioch	19	26	36	45	52
Lincoln	36	51	74	92	112
Lynch	26	37	54	67	82
North Platte	25	38	59	78	99
Scribner	38	53	76	96	116
Valentine	18	28	45	61	77
New Hampshire, Concord	18	27	45	62	79
New Jersey:					
Atlantic City	39	55	77	97	117
Marlboro	39	57	85	111	136
Trenton	29	48	76	102	131
New Mexico:					
Albuquerque	4	6	11	15	21
Roswell	10	21	34	45	53
New York:					
Albany	18	26	38	47	56
Binghamton	16	24	36	47	58
Buffalo	15	23	36	49	61
Marcellus	16	24	38	49	62
Rochester	13	22	38	54	75
Salamanca	15	21	32	40	49
Syracuse	15	24	38	51	65
North Carolina:					
Asheville	28	40	58	72	87
Charlotte	41	63	100	131	164
Greensboro	37	51	74	92	113
Raleigh	53	77	110	137	168
Wilmington	59	87	129	167	206
North Dakota:					
Devils Lake	19	27	39	49	59
Fargo	20	31	54	77	103
Williston	11	16	25	33	41
Ohio:					
Cincinnati	27	36	48	59	69
Cleveland	22	35	53	71	86
Columbiana	20	26	35	41	48
Columbus	27	40	60	77	94
Coshocton	27	45	77	108	143
Dayton	21	30	44	57	70
Toledo	16	26	42	57	74

TABLE 12.—*Expected magnitudes of single-storm erosion index values*—Continued

Location	Index values normally exceeded once in—				
	1 year	2 years	5 years	10 years	20 years
Oklahoma:					
Ardmore	46	71	107	141	179
Cherokee	44	59	80	97	113
Guthrie	47	70	105	134	163
McAlester	54	82	127	165	209
Tulsa	47	69	100	127	154
Oregon, Portland	6	9	13	15	18
Pennsylvania:					
Franklin	17	24	35	45	54
Harrisburg	19	25	35	43	51
Philadelphia	28	39	55	69	81
Pittsburgh	23	32	45	57	67
Reading	28	39	55	68	81
Scranton	23	32	44	53	63
Puerto Rico, San Juan	57	87	131	169	216
Rhode Island, Providence	23	34	52	68	83
South Carolina:					
Charleston	74	106	154	196	240
Clemson	51	73	106	133	163
Columbia	41	59	85	106	132
Greenville	44	65	96	124	153
South Dakota:					
Aberdeen	23	35	55	73	92
Huron	19	27	40	50	61
Isabel	15	24	38	52	67
Rapid City	12	20	34	48	64
Tennessee:					
Chattanooga	34	49	72	93	114
Knoxville	25	41	68	93	122
Memphis	43	55	70	82	91
Nashville	35	49	68	83	99
Texas:					
Abilene	31	49	79	103	138
Amarillo	27	47	80	112	150
Austin	51	80	125	169	218
Brownsville	73	113	181	245	312
Corpus Christi	57	79	114	146	171
Dallas	53	82	126	166	213
Del Rio	44	67	108	144	182
El Paso	6	9	15	19	24
Houston	82	127	208	275	359
Lubbock	17	29	53	77	103
Midland	23	35	52	69	85
Nacogdoches	77	103	138	164	194
San Antonio	57	82	122	155	193
Temple	53	78	123	162	206
Victoria	59	83	116	146	178
Wichita Falls	47	63	86	106	123
Vermont, Burlington	15	22	35	47	58
Virginia:					
Blacksburg	23	31	41	48	56
Lynchburg	31	45	66	83	103
Richmond	46	63	86	102	125
Roanoke	23	33	48	61	73
Washington, Spokane	3	4	7	8	11
West Virginia:					
Elkins	23	31	42	51	60
Huntington	18	29	49	69	89
Parkersburg	20	31	46	61	76
Wisconsin:					
Green Bay	18	26	38	49	59
LaCrosse	46	67	99	125	154
Madison	29	42	61	77	95
Milwaukee	25	35	50	62	74
Rice Lake	29	45	70	92	119
Wyoming:					
Casper	4	7	9	11	14
Cheyenne	9	14	21	27	34

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Field and Seed Crops

USUAL PLANTING AND HARVESTING DATES

By States In Principal Producing Areas

Agriculture Handbook No. 283
UNITED STATES DEPARTMENT OF AGRICULTURE
Statistical Reporting Service, Crop Reporting Board, Washington, D.C.

CONTENTS

	Page
Introduction	1
United States District Map	2
Crops:	
Barley	3
Corn	7
Cotton	10
Flaxseed	12
Hay, Alfalfa	14
Hay, Clover and Timothy	16
Oats	18
Peanuts	22
Rice	23
Rye	25
Sorghum	28
Soybeans	31
Sugar Beets	34
Tobacco	36
Wheat, Spring and Durum	41
Wheat, Winter	38
States:	
Alabama	44
Alaska	45
Arizona	45
Arkansas	46
California	47
Colorado	48
Delaware	49
Florida	49
Georgia	50
Hawaii	50
Idaho	51
States (Con.)	
Illinois	52
Indiana	53
Iowa	54
Kansas	55
Kentucky	56
Louisiana	57
Maryland	58
Michigan	59
Minnesota	60
Mississippi	61
Missouri	62
Montana	63
Nebraska	64
Nevada	65
New England	66
New Jersey	65
New Mexico	68
New York	69
North Carolina	70
North Dakota	71
Ohio	72
Oklahoma	73
Oregon	74
Pennsylvania	75
South Carolina	76
South Dakota	77
Tennessee	78
Texas	79
Utah	80
Virginia	81
Washington	82
West Virginia	83
Wisconsin	84
Wyoming	83

This report was prepared by C. E. Burkhead, J. W. Kirkbride, and L. A. Losleben, Field Crops Statistics Branch, Statistical Reporting Service. Primary data were provided by State statisticians.

March 1965

Field and Seed Crops
USUAL PLANTING AND HARVESTING DATES
By States In Principal Producing Areas

INTRODUCTION

This report contains information on the usual planting and harvesting dates for major field and seed crops. Information is arranged by States for major crops and by commodity for selected major crops (tables 1-66). In addition, dot maps showing major areas of production and isomaps showing periods of planting and harvesting are included for specific crops (figures 1-35). The information was assembled by the Statistical Reporting Service based on the best information readily available. This bulletin and "Commercial Vegetables for Fresh Marketing and Processing, Usual Planting and Harvesting Dates in Principal Producing Areas," Agriculture Handbook 251, June 1963, replace "Usual Planting and Harvest Time for Major Field Crops and Commercial Vegetables for Fresh Market, by States," issued in March 1948 by the Bureau of Agricultural Economics in cooperation with the Production and Marketing Administration.

The dates shown for planting and harvesting indicate the periods in which the crops are planted and harvested in most years. The periods shown do not cover exceptionally early or late dates of scattered planting and harvesting, nor do they take into account abnormal seasons caused by climatic or economic conditions. The starting and ending dates are generally considered as those periods when 5 percent and 95 percent of the acreage is involved, although these percentages will vary by crops because of differences in maturity, elevation, and area concentration.

The "usual planting dates" shown are the times when crops are usually planted in the fields. For transplanted crops, such as tobacco, the planting period refers to the time of setting plants in the field.

The "harvest dates" refer to the periods during which harvest of the crop actually occurs--combining, picking, cutting, pulling, and so on. It does not extend through the subsequent period in which some commodities are stored in the field after harvest.

The "principal producing areas" are areas of major importance in a State, even though the crop may be grown to a lesser extent elsewhere. They are designated by county or crop-reporting districts, or as statewide. Where no major defined areas of production exist, "statewide" distribution is indicated. The number designation used in the producing area column refers to crop-reporting districts which are shown on the U.S. map in figure 1.

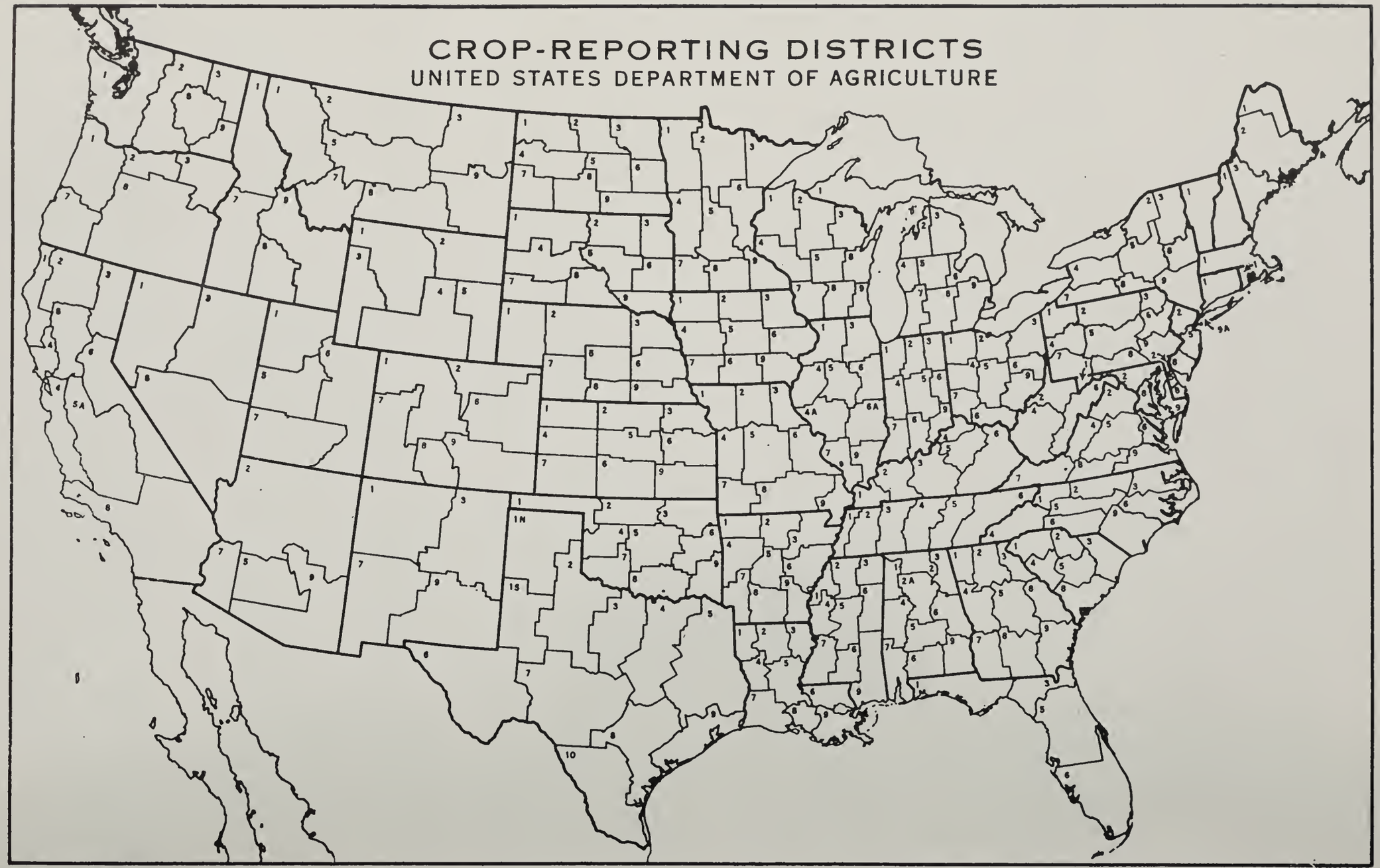

CROP-REPORTING DISTRICTS
UNITED STATES DEPARTMENT OF AGRICULTURE
U. S. DEPARTMENT OF AGRICULTURE
NEG. 24286 A
Statistical Reporting Service

Figure 1

Barley

More than 12 million acres of barley were harvested in 1962. While year-to-year fluctuations have occurred, acreage is still at about the same level as in the late twenties. Yields, however, have been steadily increasing.

The major barley-producing State is North Dakota, where almost one-fourth of the U. S. acreage is sown. This State, together with California and Montana, the second and third ranking producing States, accounts for about 50 percent of the Nation's annual acreage and production. Only minor acreages are grown in the eastern and southern parts of the United States. Most barley is fed to livestock, although about 20 percent of the crop is used for malting.

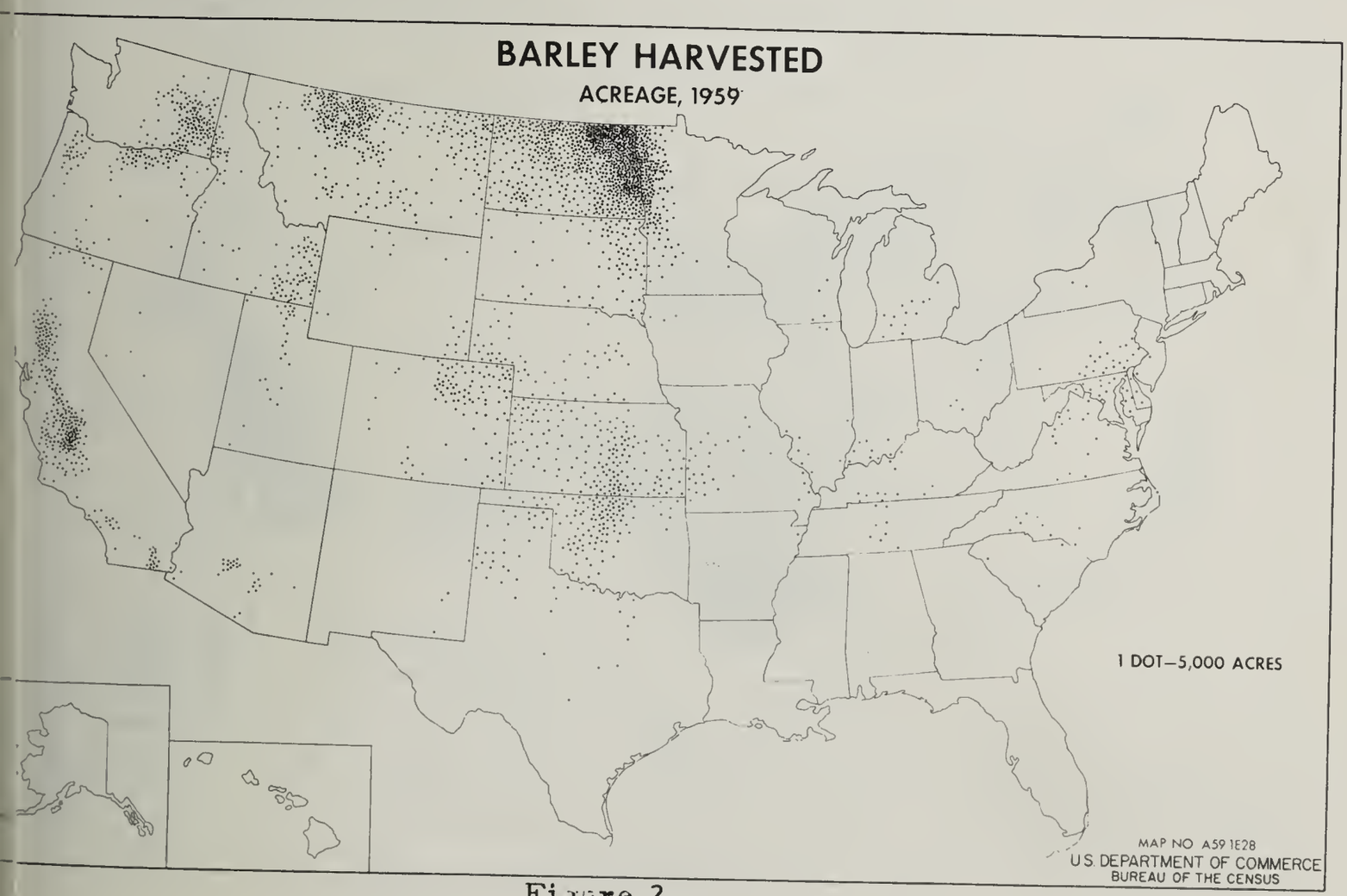
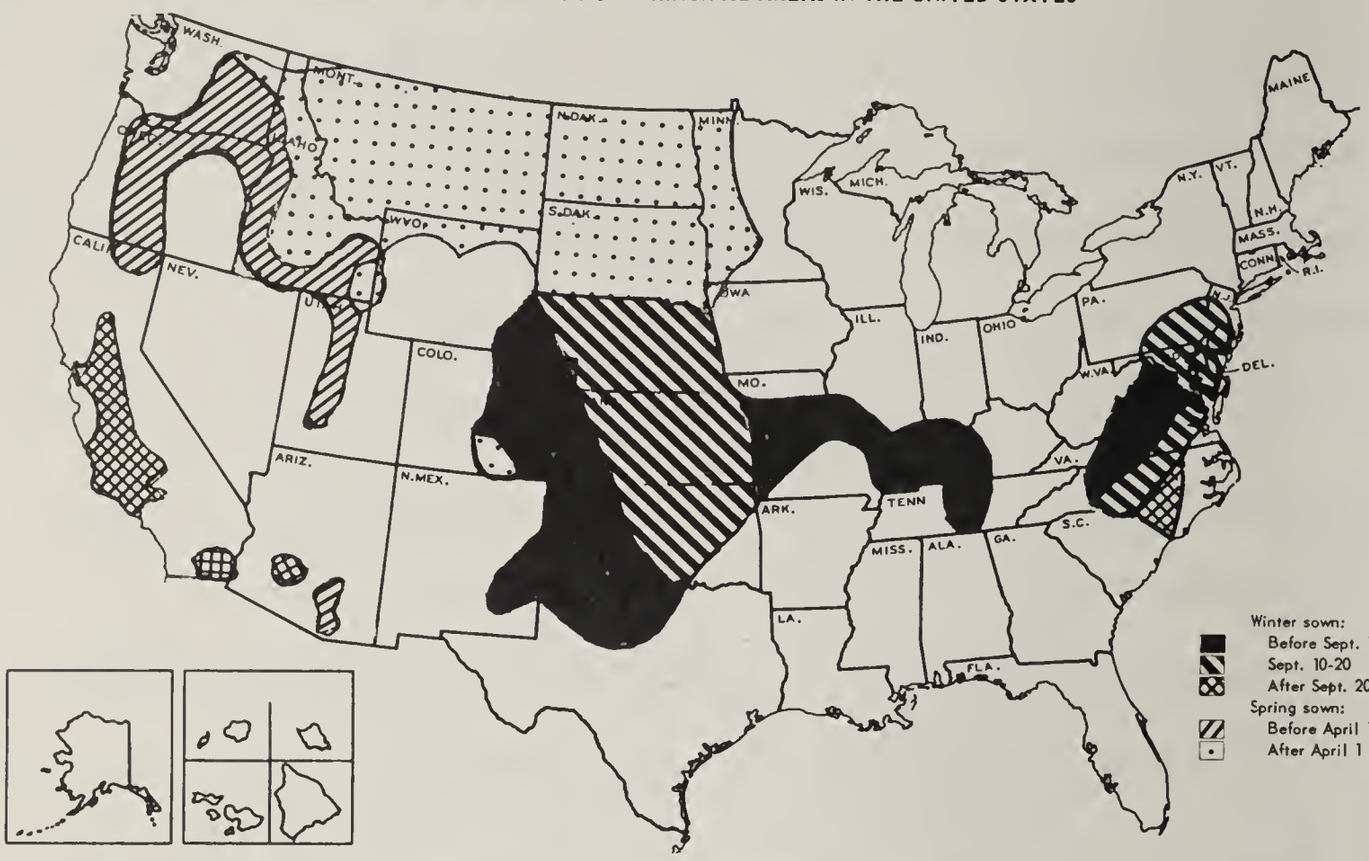


Figure 2

BARLEY
USUAL START OF PLANTING – PRINCIPAL AREAS IN THE UNITED STATES

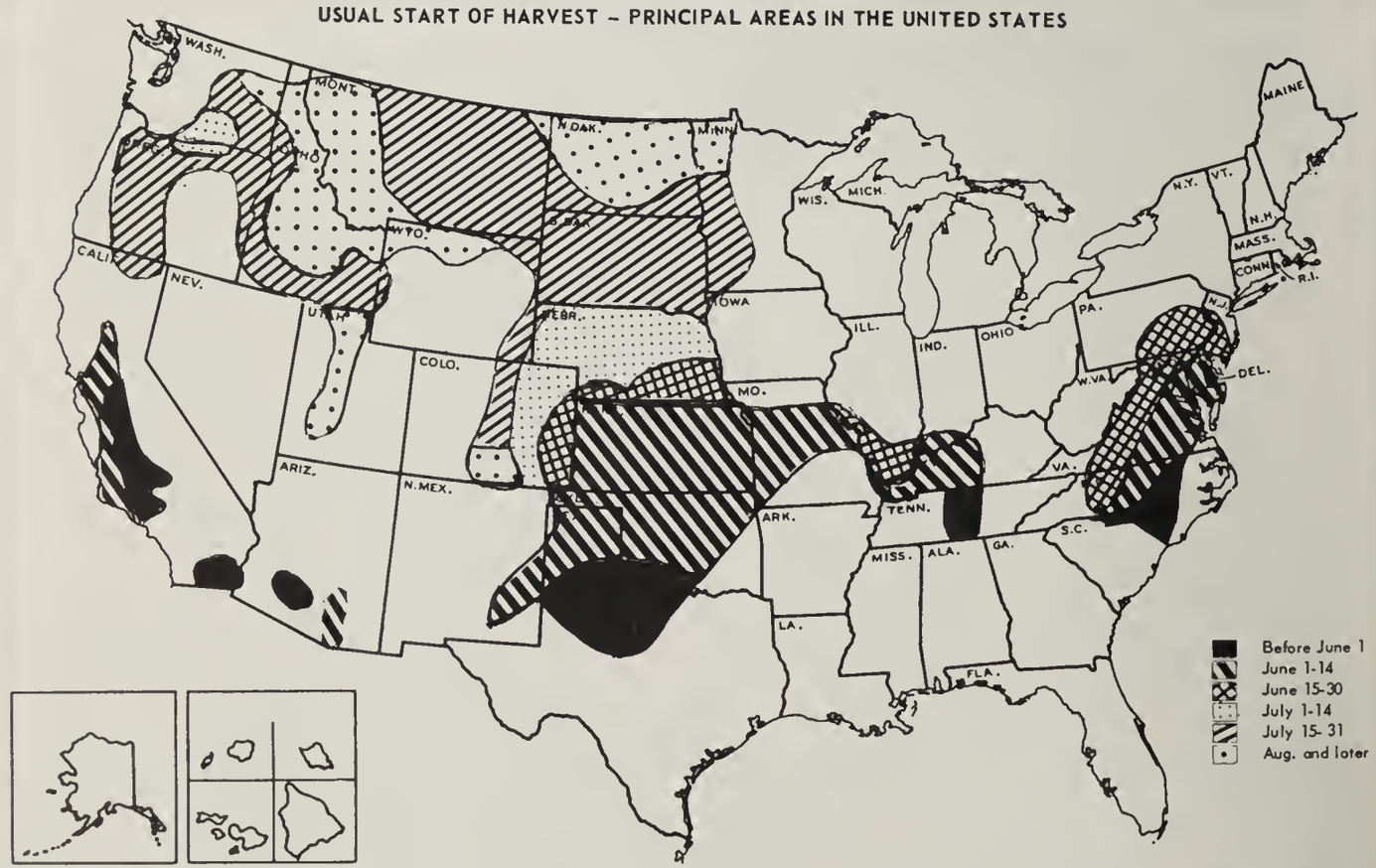


U. S. DEPARTMENT OF AGRICULTURE

Figure 3

STATISTICAL REPORTING SERVICE M–1

BARLEY FOR GRAIN
USUAL START OF HARVEST – PRINCIPAL AREAS IN THE UNITED STATES



U. S. DEPARTMENT OF AGRICULTURE

Figure 4

STATISTICAL REPORTING SERVICE M–2

Table 1.--Barley: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
New York						
Fall sown	19	Aug. 25 - Sept. 10	July 15	July 20-July 30	Aug. 5	4, 8
Spring sown		Apr. 25 - Aug. 5	Aug. 5	Aug. 10-Aug. 30	Sept. 1	Statewide
New Jersey						
Fall sown	21	Sept. 15 - Sept. 30	June 15	June 20-July 10	July 15	5, 8
Spring sown		Mar. 25 - Apr. 20	June 15	June 20-July 10	July 15	5, 8
Pennsylvania						
Fall sown	184	Sept. 10 - Oct. 1	June 20	June 25-July 5	July 10	4, 5, 6, 7, 8, 9
Spring sown		Apr. 25 - May 25	July 25	Aug. 1-Aug. 15	Aug. 20	1, 2, 3
Ohio						
Fall sown	45	Sept. 5 - Oct. 10	June 20	July 1-July 10	July 15	Statewide
Spring sown		Apr. 5 - May 10	July 15	July 25-Aug. 5	Aug. 20	Northern half of State
Indiana						
Fall sown	42	Sept. 1 - Sept. 30	June 10	June 15-June 25	July 1	4, 5, 6, 7, 8, 9
Spring sown		Apr. 1 - Apr. 20	July 1	July 10-July 20	July 30	1, 2, 3, 4, 5, 6
Illinois						
Fall sown	52	Aug. 20 - Sept. 20	June 20	June 25-July 5	July 15	4a, 6a, 7, 9
Spring sown		Apr. 5 - Apr. 30	July 15	July 20-July 30	Aug. 5	1, 3
Michigan						
Fall sown	62	Sept. 5 - Sept. 15	June 25	July 1-July 10	Aug. 1	5, 8, 9
Spring sown		Apr. 10 - May 10	July 15	July 20-Aug. 1	Aug. 5	6, 7
Wisconsin	30	Apr. 15 - May 15	July 15	July 20-July 30	Aug. 15	Rock, Walworth, Dodge, Fond du Lac, Racine
Minnesota	719	Apr. 15 - May 20	July 20	Aug. 1-Aug. 18	Sept. 5	1, 4
Iowa	11	Apr. 1 - Apr. 25	July 15	July 20-July 30	Aug. 10	Statewide
Missouri	101	Sept. 1 - Oct. 10	June 1	June 5-June 15	June 20	6, 7, 8, 9
North Dakota	2,887	Apr. 15 - June 5	July 25	Aug. 1-Aug. 15	Aug. 30	Statewide
South Dakota	409	Apr. 5 - May 5	July 15	July 25-Aug. 5	Aug. 10	2, 3, 5, 6, 8, 9
Nebraska						
Fall sown	135	Sept. 10 - Oct. 10	June 25	July 10-July 20	Aug. 20	1, 7
Spring sown		Apr. 5 - May 1	June 25	July 10-July 20	Aug. 20	1, 7
Kansas						
Fall sown	689	Sept. 10 - Nov. 1	June 10	June 15-July 1	July 5	Statewide
Spring sown		Feb. 25 - June 1	June 25	June 25-July 10	July 15	Statewide
Delaware	14	Sept. 25 - Nov. 10	June 10	June 20-July 5	July 10	Statewide
Maryland	91	Sept. 25 - Nov. 10	June 10	June 20-July 5	July 10	Statewide
Virginia	112	Sept. 5 - Nov. 1	June 1	June 20-July 1	July 15	2, 4, 5, 6
West Virginia	10	Sept. 15 - Oct. 20	June 25	July 1-July 25	Aug. 1	6
North Carolina	66	Sept. 20 - Oct. 30	May 20	June 10-June 25	July 1	5, 8, 9

Table 1.--Barley: Usual planting and harvesting dates by States and principal producing areas--Con.

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
South Carolina	22	Oct. 1 - Dec. 1	May 20	May 25-June 15	June 20	Statewide
Georgia	12	Oct. 1 - Dec. 1	May 20	May 25-June 5	June 15	1, 2, 3, 4, 5, 6
Kentucky	53	Aug. 20 - Sept. 30	June 5	June 15-July 1	July 10	2, 3
Tennessee	35	Sept. 1 - Nov. 1	May 25	June 1-June 20	July 1	3, 4, 5
Arkansas	28	Sept. 1 - Nov. 20	June 1	June 10-June 25	July 5	Statewide
Oklahoma						
Fall sown	547	Sept. 10 - Nov. 5	June 1	June 5-June 20	July 1	1, 2, 3, 4, 5, 7, 8
Spring sown		Jan. 20 - Mar. 15	June 1	June 5-June 20	July 1	1, 2, 3, 4, 5, 7, 8
Texas	227	Sept. 10 - Nov. 25	May 15	May 25-June 15	Jan. 30	1n, 2n, 2s, 4
Montana	1,802	Apr. 1 - May 30	July 25	Aug. 5-Aug. 25	Sept. 10	Statewide
Idaho						
Fall sown	648	Sept. 1 - Oct. 10	July 15	July 25-Aug. 15	Aug. 25	1, 9
Spring sown		Mar. 25 - May 25	July 25	Aug. 5-Sept. 20	Sept. 30	Statewide
Wyoming	112	Apr. 5 - May 20	Aug. 1	Aug. 5-Aug. 20	Aug. 30	Statewide
Colorado						
Fall sown	431	Sept. 1 - Oct. 15	June 20	July 1-July 20	Aug. 5	2, 6, 9
Spring sown		Mar. 15 - Apr. 30	June 30	July 5-Aug. 15	Aug. 15	1, 2, 6, 7, 8
New Mexico						
Fall sown	37	Sept. 1 - Nov. 1	June 10	June 15-July 10	July 20	1, 3, 7, 9
Spring sown		Feb. 15 - Apr. 1	June 20	June 25-July 15	Aug. 1	1, 3, 7, 9
Arizona						
Fall sown	120	Oct. 1 - Dec. 31	May 20	May 25-June 10	June 20	5
Spring sown		Jan. 20 - Feb. 28	June 10	June 15-June 30	July 5	9
Utah	155	Mar. 20 - Apr. 25	Aug. 1	Aug. 10-Sept. 5	Sept. 15	Statewide
Nevada						
Fall sown	13	Sept. 1 - Oct. 20	June 15	July 1-Aug. 15	Sept. 1	Pershing, Churchill,
Spring sown		Apr. 20 - May 10	July 20	July 25-Aug. 15	Sept. 1	Lyon, Douglas, Clark
Washington						
Fall sown	621	Sept. 5 - Nov. 10	July 1	July 15-Aug. 10	Aug. 20	2, 3, 5, 9
Spring sown		Mar. 10 - Apr. 1	July 5	July 20-Aug. 15	Sept. 1	2, 3, 5, 9
Oregon						
Fall sown	407	Aug. 15 - Feb. 1	July 5	July 15-Aug. 5	Aug. 15	1, 2, 3, 8
Spring sown		Feb. 15 - May 15	July 25	Aug. 5-Aug. 20	Sept. 15	Statewide
California						
Fall sown	1,461	Oct. 15 - Apr. 15	May 15	June 1-July 15	Aug. 15	4, 5, 5a, 8
Spring sown		Mar. 1 - May 1	Aug. 15	Sept. 1-Sept. 20	Sept. 30	Modoc, Siskiyou
Alaska	2.2	May 1 - June 10	Sept. 5	Sept. 25-Oct. 10	Oct. 15	Tanana and Matanuska Valleys

Corn

Corn is the leading crop in American agriculture both in terms of value and of acreage grown each year. In 1962, nearly 57 million acres of corn were harvested for grain, producing 3,637 million bushels. The acreage for grain comprised 86 percent of the corn grown for all purposes. Nearly three-fourths of the corn-for-grain acreage lies in the Corn Belt, with Iowa the leading State and Illinois second. Corn-for-grain estimates began in 1919. The largest acreage of record, 97 million, was harvested in 1932. Acreage gradually declined, except for larger wartime plantings, and was down to 72 million acres by 1950. The downtrend continued to about 63 million acres in 1957 and 1958 as allotments were in force in commercial counties for producers desiring price support. With the discontinuance of allotments in 1959, acreage returned to the 1950 level of 72 million, but declined with the advent of the Feed Grain Program in 1961. The average yield per acre has trended upward since 1940 with more rapid increases since the mid-1950's, resulting in a new record being established nearly each year since 1955. The 1962 yield was 64.2 bushels per acre.

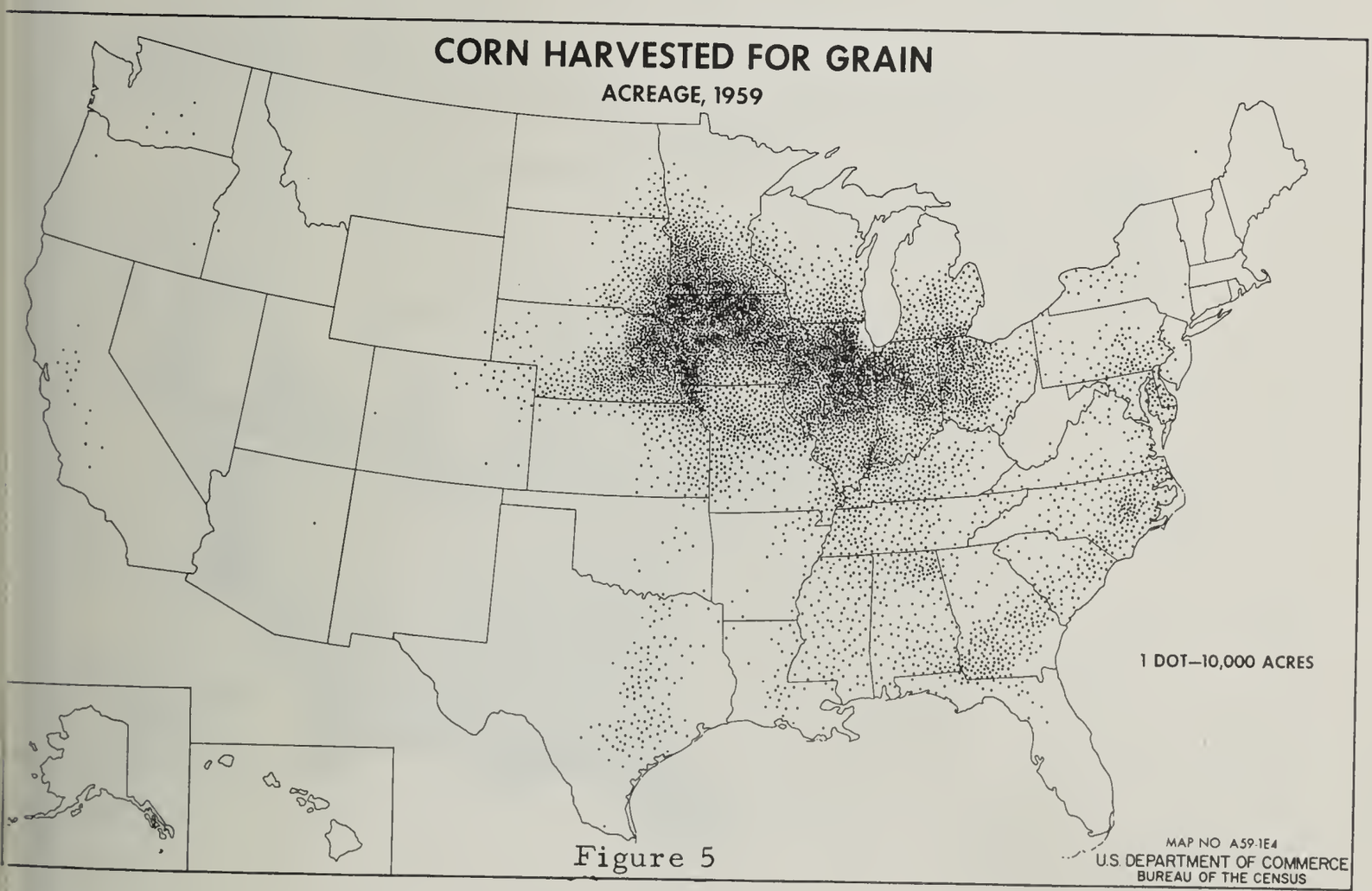


Figure 5

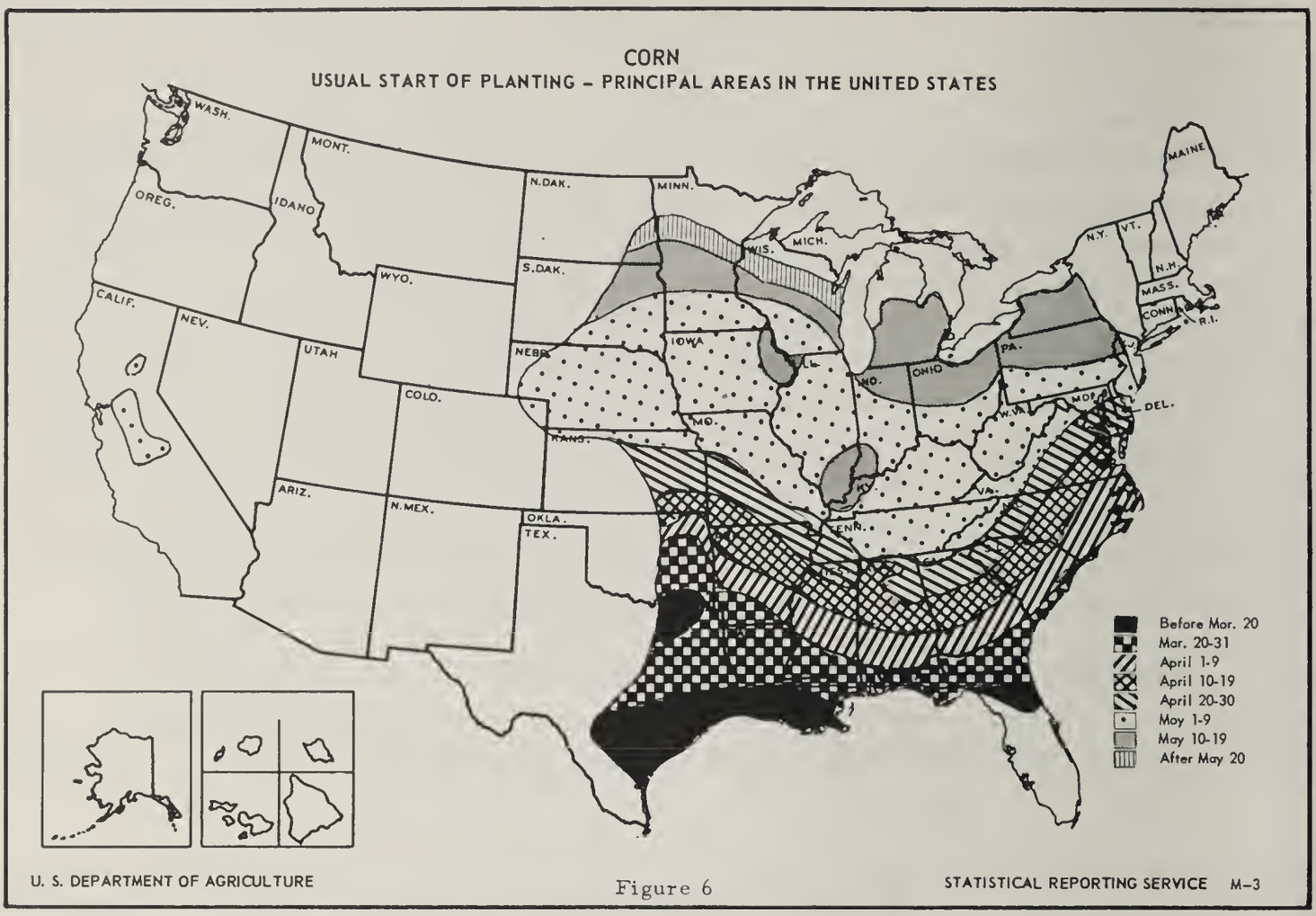


Figure 6

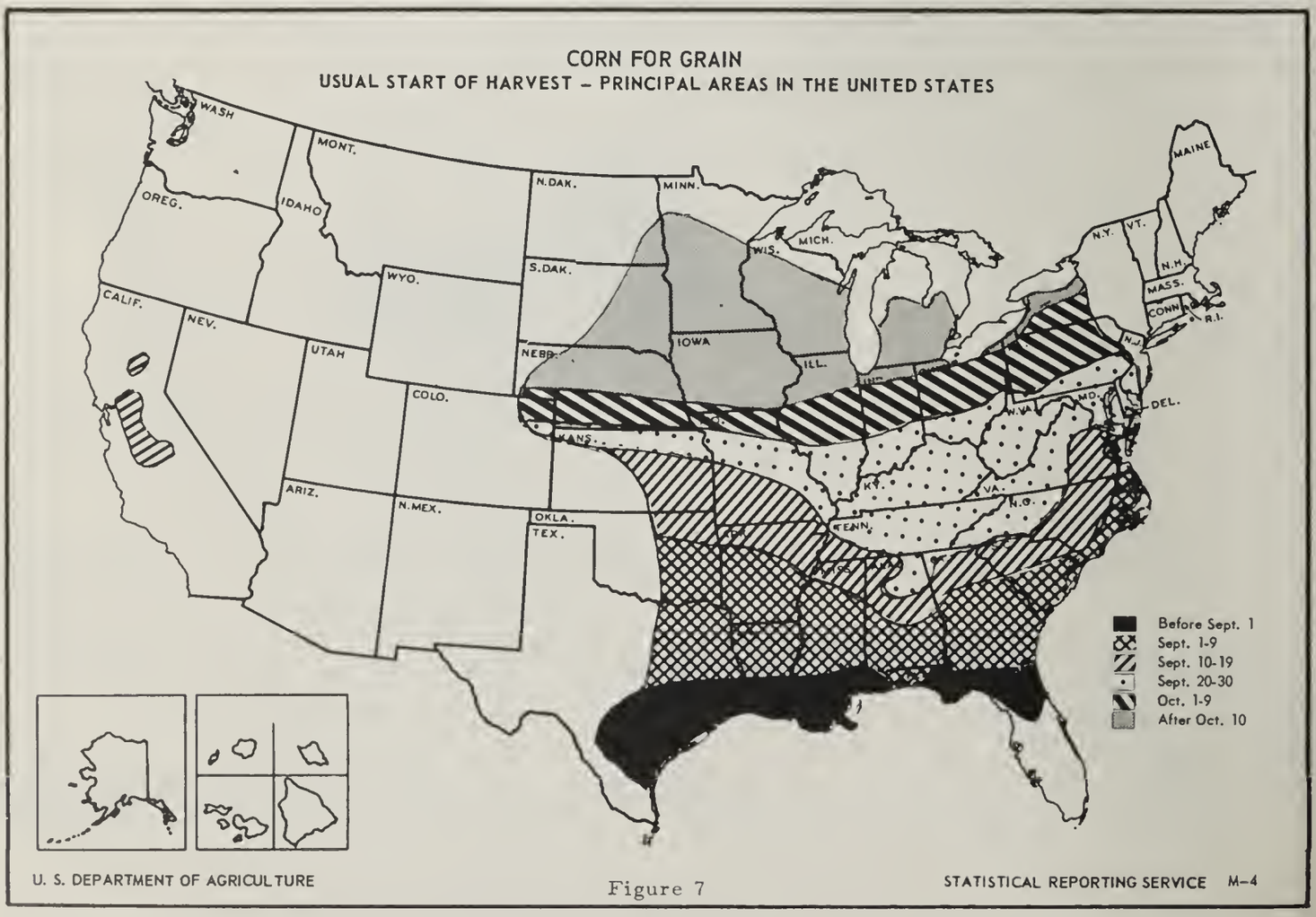


Figure 7

Table 2.--Corn: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Vermont	1	May 20-June 20	Oct. 1	Oct. 15-Oct. 25	Nov. 1	Statewide
Massachusetts	2	May 15-June 20	Oct. 1	Oct. 15-Oct. 25	Nov. 1	Statewide
Connecticut	2	May 15-June 20	Oct. 1	Oct. 15-Oct. 25	Nov. 1	Statewide
New York	181	May 20-June 15	Oct. 15	Oct. 25-Nov. 15	Dec. 1	4, Cayuga
New Jersey	78	May 15-June 15	Oct. 5	Oct. 20-Nov. 5	Nov. 25	Statewide
Pennsylvania	788	May 5-June 20	Sept.20	Oct. 1-Oct. 20	Nov. 10	5, 8, 9
Ohio	2,663	May 5-June 10	Sept.25	Oct. 15-Nov. 10	Dec. 1	Statewide
Indiana	4,298	May 5-June 5	Oct. 5	Oct. 15-Nov. 15	Nov. 30	Statewide
Illinois	8,270	May 5-June 20	Oct. 5	Oct. 20-Nov. 15	Dec. 5	Statewide
Michigan	1,408	May 5-June 10	Oct. 10	Oct. 20-Nov. 10	Dec. 1	5, 6, 7, 8, 9
Wisconsin	1,533	May 5-June 15	Sept.25	Oct. 5-Oct. 30	Nov. 15	Statewide
Minnesota	4,575	May 10-June 5	Oct. 5	Oct. 21-Nov. 9	Nov. 30	4, 5, 6, 7, 8, 9
Iowa	9,776	May 5-June 5	Oct. 5	Oct. 25-Nov. 20	Dec. 10	Statewide
Missouri	2,982	Apr.25-May 31	Sept.15	Oct. 1-Nov. 10	Nov. 30	Statewide
North Dakota	169	May 15-June 20	Oct. 1	Oct. 1-Oct. 15	Nov. 1	6, 9
South Dakota	2,659	May 5-June 1	Oct. 5	Oct. 20-Nov. 5	Nov. 15	2, 3, 5, 6, 9
Nebraska	5,031	May 5-June 10	Oct. 15	Nov. 1-Nov. 20	Dec. 5	3, 5, 6, 9
Kansas	1,298	Apr.15-June 10	Sept.15	Oct. 5-Nov. 10	Dec. 5	Statewide
Delaware	119	May 1-June 15	Sept.15	Sept.20-Oct. 20	Nov. 15	Statewide
Maryland	354	May 1-June 15	Sept.15	Oct. 1-Nov. 1	Nov. 20	Statewide
Virginia	534	Apr.15-June 25	Sept.1	Oct. 1-Nov. 10	Dec. 1	Statewide
West Virginia	71	May 1-June 5	Sept.15	Sept.25-Oct. 20	Nov. 1	Statewide
North Carolina	1,259	Apr. 5-June 5	Sept.5	Oct. 5-Nov. 15	Jan. 10	Statewide
South Carolina	487	Apr. 1-May 25	Sept.15	Oct. 1-Dec. 5	Dec. 15	Statewide
Georgia	1,692	Mar.20-May 25	Sept.1	Sept.15-Nov. 1	Dec. 1	Statewide
Florida	315	Mar. 5-Apr. 15	Aug. 15	Sept. 1-Sept.30	Oct. 15	1, 3, 5
Kentucky	1,116	Apr.25-June 20	Sept.25	Oct. 5-Nov. 5	Nov. 20	Statewide
Tennessee	961	Apr.20-June 20	Sept.25	Oct. 15-Nov. 15	Dec. 15	Statewide
Alabama	1,229	Apr. 1-June 5	Aug. 25	Oct. 1-Nov. 20	Dec. 5	Statewide
Mississippi	764	Apr. 1-May 31	Sept.1	Oct. 15-Nov. 15	Dec. 15	Statewide
Arkansas	207	Apr.10-May 25	Sept.15	Oct. 1-Nov. 20	Dec. 10	Statewide
Louisiana	222	Mar. 1-Apr. 30	Aug. 1	Sept. 1-Oct. 1	Oct. 15	Statewide
Oklahoma	123	Mar.25-May 10	Sept.1	Sept.15-Oct. 15	Nov. 20	3, 5, 6, 8, 9
Texas	1,052	Mar. 5-May 10	Aug. 5	Aug. 15-Sept.20	Oct. 20	4, 5n, 8n, 9
Montana	4	May 10-June 10	Sept.15	Sept.20-Oct. 5	Oct. 15	Statewide
Idaho	23	May 1-May 25	Oct. 10	Oct. 20-Nov. 15	Dec. 10	7, 8
Wyoming	8	May 10-June 15	Oct. 15	Nov. 1-Nov. 15	Nov. 30	1, 2, 5
Colorado	198	Apr.20-May 20	Sept.25	Oct. 15-Nov. 10	Nov. 20	2, 6, 7, 9
New Mexico	12	Apr.15-June 1	Sept.15	Oct. 10-Nov. 1	Dec. 1	1, 3, 7, 9
Arizona	15	Apr.15-June 1	Aug. 15	Oct. 1-Oct. 25	Nov. 10	2, 9
Utah	3	May 10-June 10	Sept.1	Sept.15-Oct. 10	Oct. 15	Davis, Utah, Duchesne, Emery, Weber
Washington	30	May 5-June 5	Oct. 15	Oct. 25-Nov. 20	Dec. 15	2, 5
Oregon	20	May 5-June 10	Sept.15	Sept.25-Oct. 10	Oct. 20	1, Umatilla, Malheur, Josephine
California	77	May 1-July 1	Sept.15	Oct. 1-Nov. 10	Nov. 30	5a, Sacramento, Solano, Butte

Cotton

Cotton is grown in southern areas of the United States, mostly south of the 36th parallel. Cotton belongs to the mallow family and requires a long, frost-free season. Under tropical conditions, plants continue to grow each year and develop into trees. In the United States, cotton is grown as an annual from seed planted after soils become sufficiently warm. However, some cotton in Arizona is grown from surviving stubble of the previous year's crop and is called "stub cotton." Planting gets underway in the Lower Valley of Texas the latter part of February and moves north across the Cotton Belt as the season advances. The bulk of the U.S. crop is planted during April, but in some late years planting is not completed until around mid-June, especially in the Plains areas of Texas. Although the first bale is ginned in June from the early-planted cotton in the Lower Valley of Texas, the bulk of the U.S. crop is harvested in October and November except in the Plains areas of Texas. In that area, strippers are used to harvest the crop after the first freeze with peak ginning during December in most years. Most cotton grown in the United States is Upland cotton with a staple length of 1 inch or longer. Some extra-long-staple cotton (American-Egyptian), which has a staple of $1\frac{1}{2}$ inches or longer, is grown in Texas, New Mexico, and Arizona.

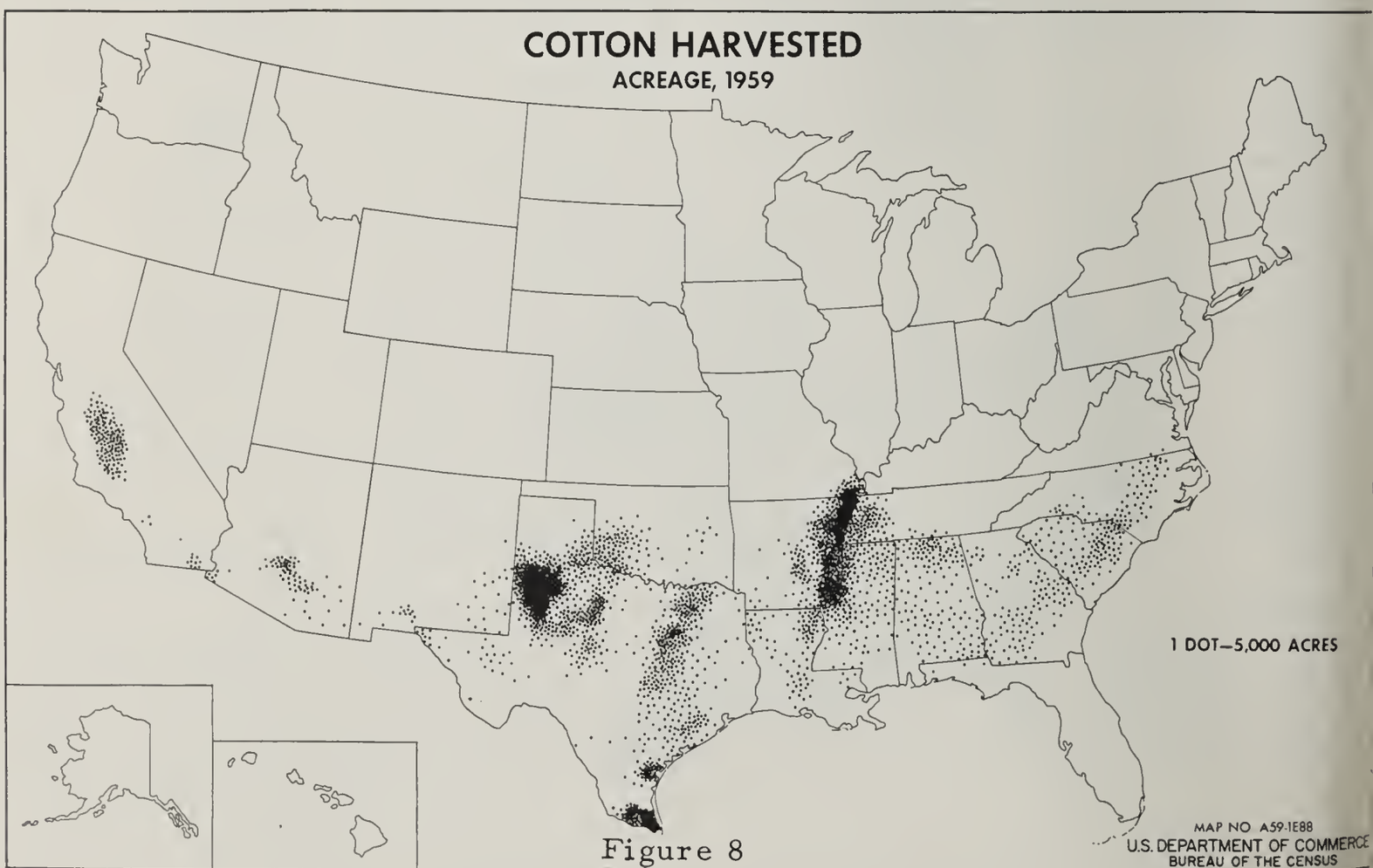


Figure 8

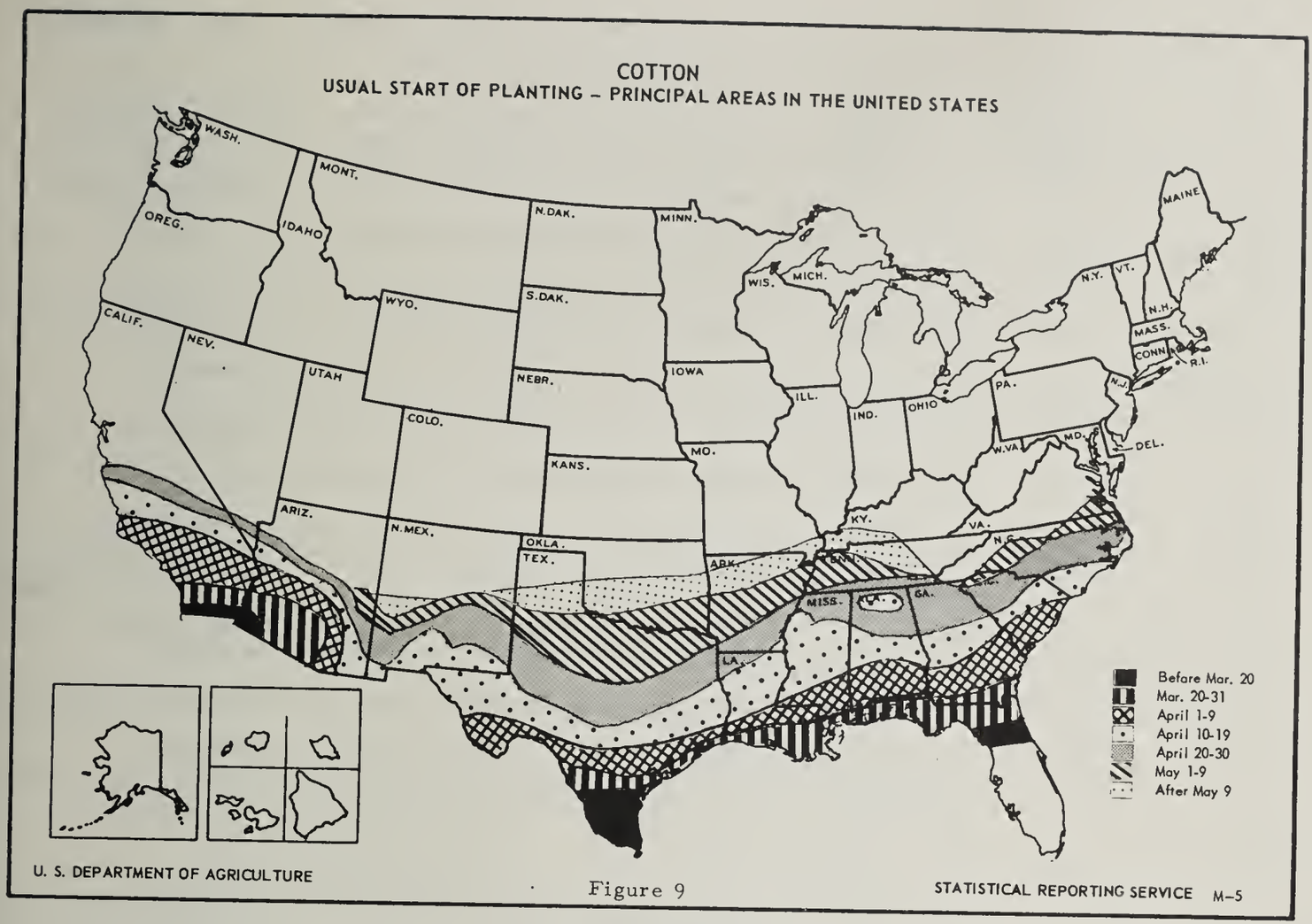


Figure 9

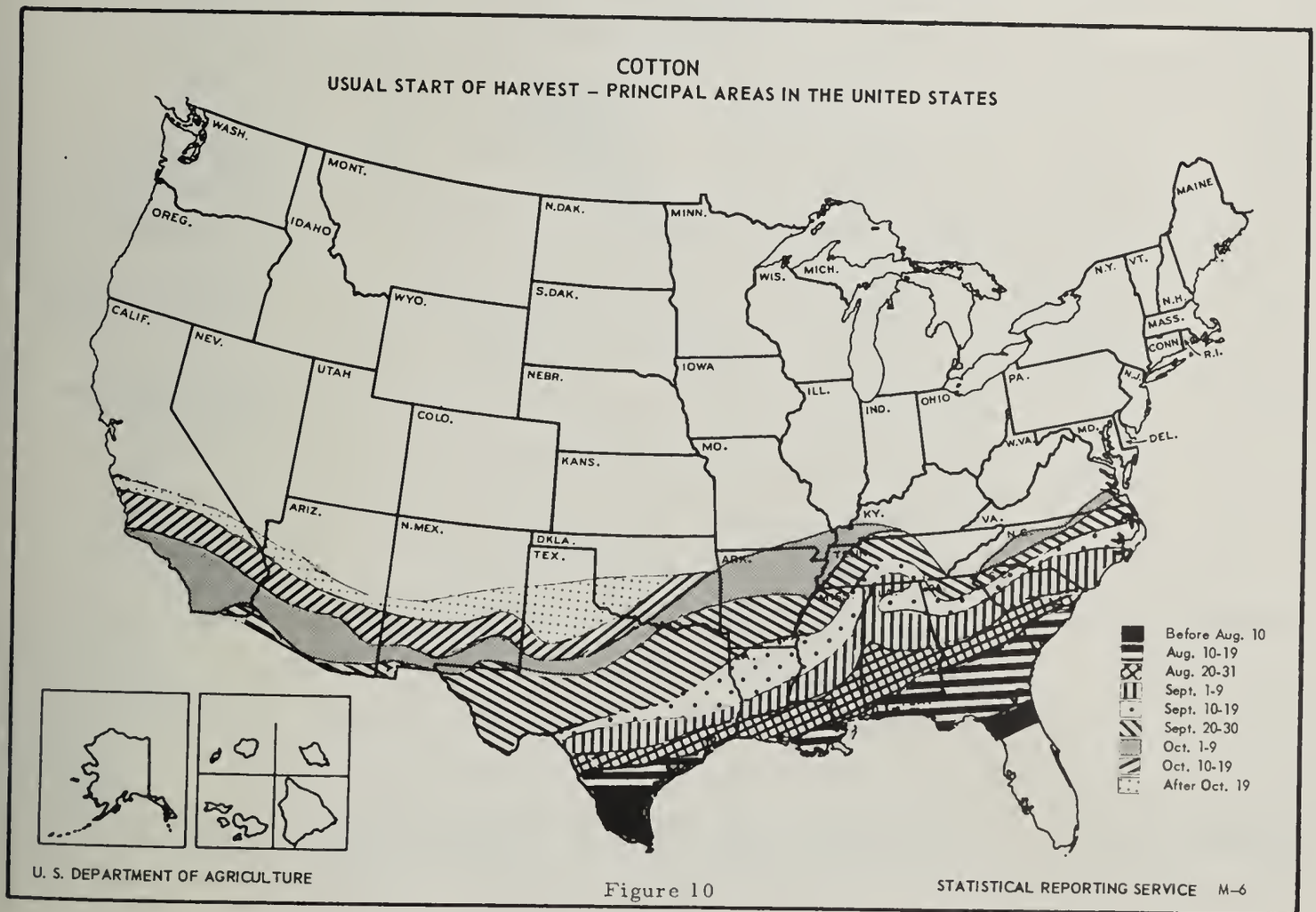


Figure 10

Table 3.--Cotton: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Illinois	2	Apr. 20-May 15	Sept. 15	Sept. 30-Oct. 25	Nov. 5	Alexander, Pulaski
Missouri	383	Apr. 20-May 20	Sept. 15	Oct. 1-Nov. 15	Dec. 1	9
Virginia	14.8	Apr. 15-May 25	Sept. 15	Sept. 25-Nov. 1	Dec. 10	9
North Carolina	402	Apr. 10-May 20	Sept. 5	Sept. 25-Nov. 1	Dec. 1	2, 3, 5, 6, 8, 9
South Carolina	575	Apr. 10-May 20	Aug. 25	Sept. 5-Nov. 1	Nov. 15	Statewide
Georgia	692	Apr. 1-May 10	Aug. 20	Sept. 1-Oct. 1	Nov. 15	Statewide
Florida	20.6	Apr. 1-Apr. 30	Aug. 15	Aug. 25-Oct. 1	Oct. 15	1, 3
Kentucky	6.5	Apr. 20-May 20	Sept. 15	Oct. 1-Oct. 25	Dec. 1	Fulton, Hickman
Tennessee	538	Apr. 20-May 25	Sept. 15	Sept. 25-Nov. 5	Dec. 5	1, 2 and southern part 3 and 4
Alabama	900	Apr. 10-May 20	Sept. 1	Sept. 10-Oct. 25	Nov. 20	Statewide
Mississippi	1,585	Apr. 10-May 20	Sept. 5	Sept. 20-Oct. 20	Nov. 30	1, 2, 4
Arkansas	1,355	Apr. 25-May 25	Sept. 10	Oct. 1-Oct. 10	Dec. 15	Statewide
Louisiana	565	Apr. 10-May 10	Aug. 25	Sept. 15-Nov. 15	Dec. 1	1, 2, 3, 5
Oklahoma	612	May 1-June 10	Sept. 20	Oct. 1-Nov. 30	Dec. 15	4, 7
Texas	6,500	Mar. 10-June 15	July 25	Sept. 5-Dec. 10	Jan. 10	Statewide
New Mexico	201	Apr. 1-May 15	Sept. 25	Oct. 15-Nov. 20	Jan. 1	3, 7, 9
Arizona	405	Mar. 15-Apr. 25	Sept. 15	Oct. 25-Dec. 5	Jan. 15	5, 7, 9
Nevada	3.5	Apr. 1-Apr. 20	Oct. 1	Oct. 25-Dec. 15	Jan. 1	Nye
California	809	Apr. 1-May 1	Oct. 1	Oct. 15-Dec. 1	Jan. 15	Fresno, Kings, Kern, Tulare, Imperial

Table 4.--Flaxseed: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Wisconsin	4	Apr. 15-May 15	July 20	July 25-July 30	Aug. 15	Ozaukee, Sheboygan, Pierce Brown, Bayfield
Minnesota	510	Apr. 20-June 5	Aug. 10	Aug. 18-Sept.15	Oct. 10	1, 4, 7
Iowa	10	Apr. 10-May 10	July 15	July 25-Aug. 10	Aug. 20	1, 2
North Dakota	1,627	May 1-June 25	Aug. 10	Aug. 15-Sept.15	Oct. 5	Statewide
South Dakota	577	Apr. 20-June 1	Aug. 5	Aug. 15-Aug. 25	Sept. 5	2, 3, 6
Nebraska		Apr. 15-Apr. 25	Aug. 15	Aug. 20-Sept.20	Oct. 1	1
Texas	25	Nov. 1-Dec. 20	May 1	May 15-June 1	June 10	8n, 8s, 10n
Montana	23	Apr. 20-June 10	Aug. 25	Sept. 5-Sept.20	Oct. 5	2, 3
California	32	Nov. 1-Jan. 15 Nov. 15-May 1	May 15 Aug. 15	June 15-July 5 Sept. 1-Sept.15	July 20 Sept.30	Imperial San Mateo

Flaxseed

Most of the flaxseed produced in the United States is located in three States--North Dakota, South Dakota, and Minnesota. The total acreage harvested in 1962 was 2.8 million acres, of which more than half was located in North Dakota. Flax in this country and in adjacent parts of Canada is grown primarily for the seed, which yields linseed oil used in the manufacture of paint and other industrial products. Yields vary considerably from year to year mainly because of the fluctuations in weather, particularly rainfall, in the main producing areas. Production in recent years has ranged from 5.2 bushels per acre in 1957 to 11.5 bushels per acre in 1962.

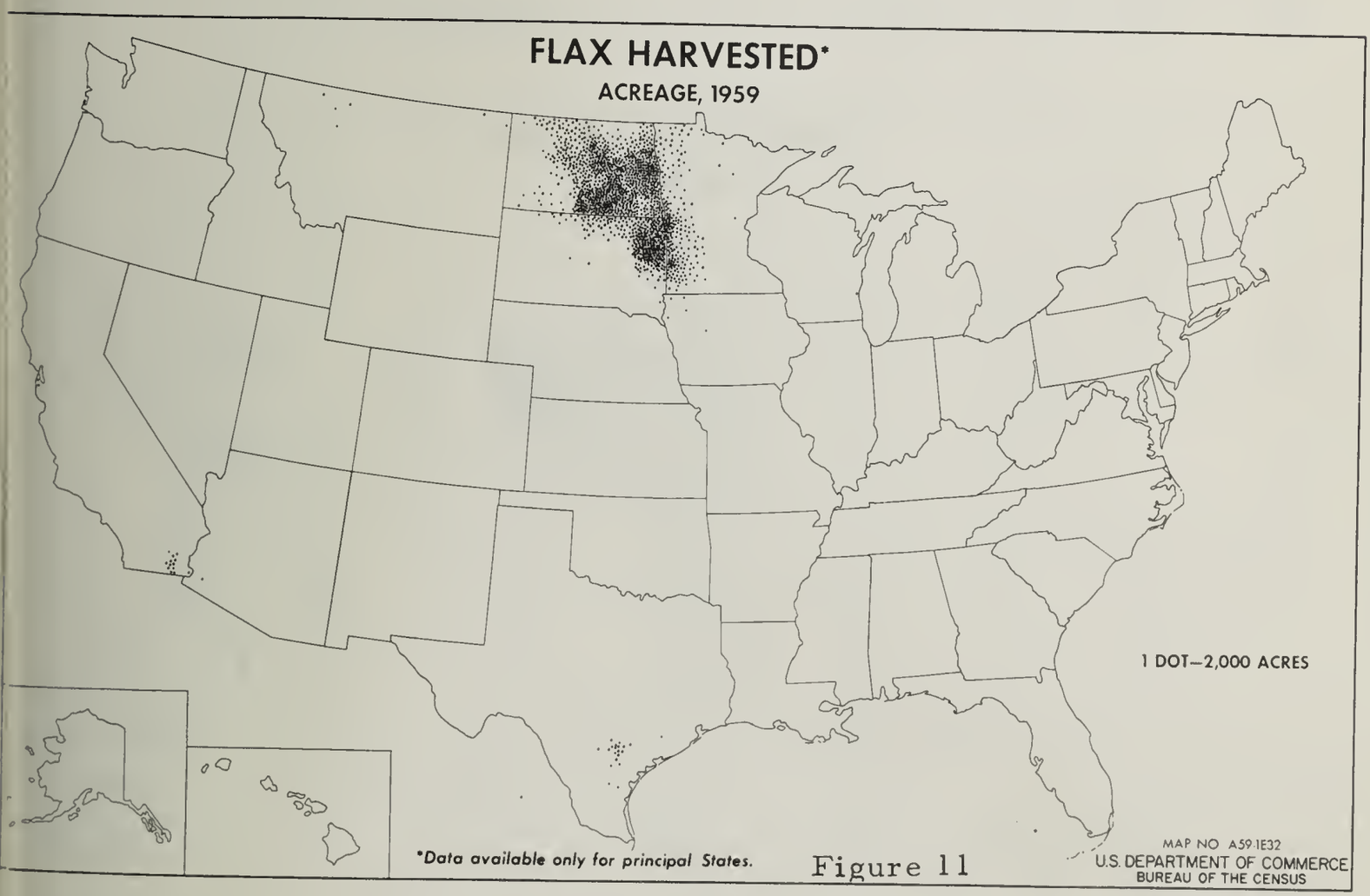


Figure 11

Hay--Alfalfa

About 42 percent of the total acreage of hay crops is alfalfa hay, which includes alfalfa and alfalfa mixtures used for hay and for dehydrating. Alfalfa is common in all areas of the United States except the Southeast, where the humid climate and sandy soils are not favorable for production. Soils with adequate lime are the most favorable for growing alfalfa. In most areas, the crop is harvested two or three times a year, and yields range from 2 to 3 tons per acre. Annual yields are particularly high in the Southwest because of the long growing season and the common use of irrigation water. In 1962, the California yield was 5.2 tons and the Arizona yield was 4.8 tons per acre. Four States cut more than 2 million acres in 1962 -- Wisconsin, Minnesota, Iowa, and South Dakota.

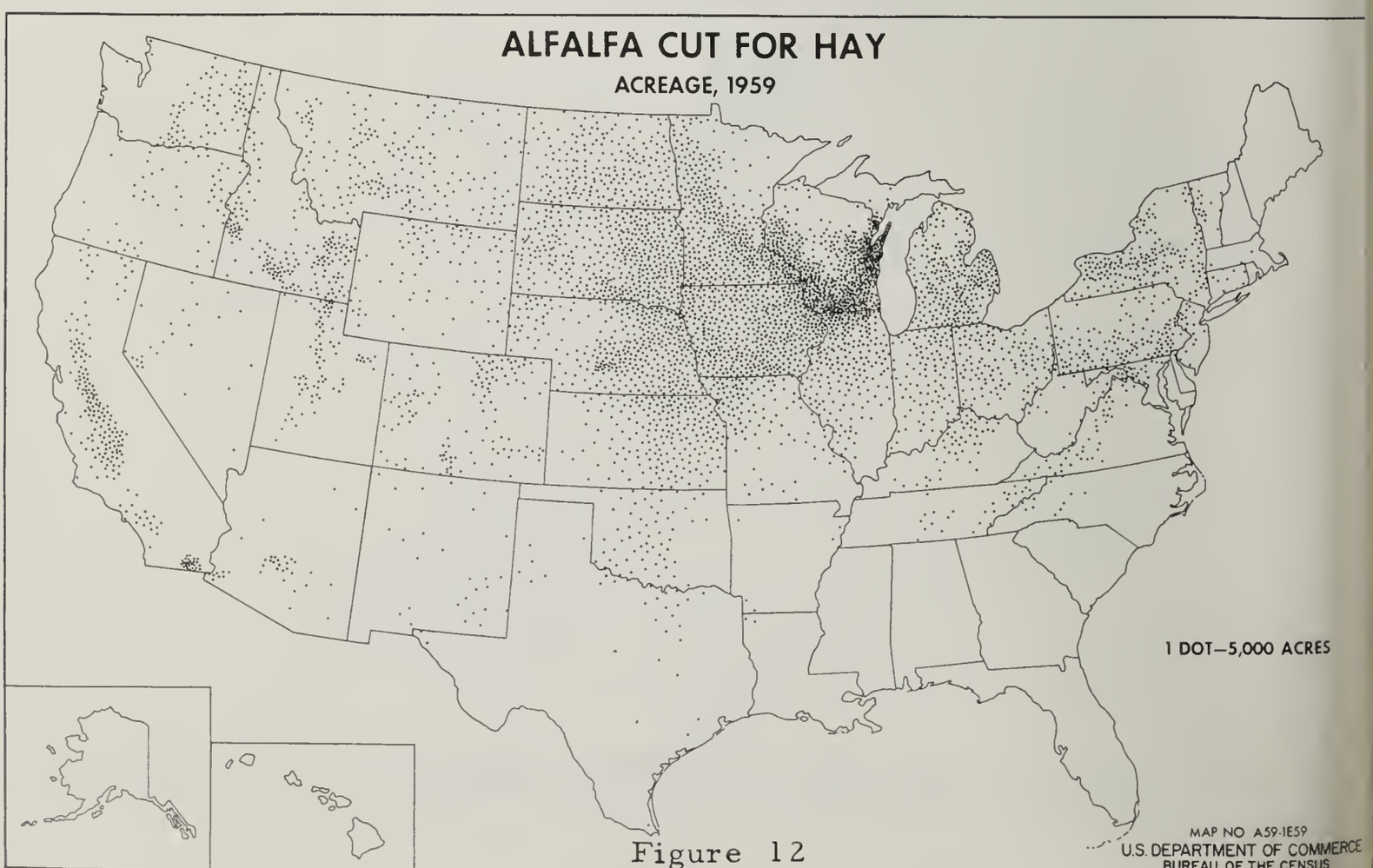


Figure 12

Table 5.--Hay, Alfalfa: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Maine	9	---	June 15	---	Sept. 10	Statewide
New Hampshire	13	---	June 15	---	Sept. 10	Statewide
Vermont	116	---	June 15	---	Sept. 10	Statewide
Massachusetts	34	---	June 5	---	Sept. 15	Statewide
Rhode Island	5	---	June 5	---	Sept. 15	Statewide
Connecticut	40	---	June 5	---	Sept. 15	Statewide
New York	1,052	---	June 1	---	Sept. 10	Statewide
New Jersey	89	---	May 25	---	Sept. 20	Statewide
Pennsylvania	771	---	May 20	---	Oct. 1	Statewide
Ohio	792	---	June 1	---	Sept. 25	Statewide
Indiana	563	---	May 25	---	Sept. 10	Statewide
Illinois	1,070	---	May 30	---	Sept. 5	Statewide
Michigan	1,235	---	June 10	---	Sept. 1	Statewide
Wisconsin	2,929	---	June 15	---	Sept. 10	Statewide
Minnesota	2,457	---	June 20	---	Aug. 30	Statewide
Iowa	2,232	---	May 30	---	Sept. 10	Statewide
Missouri	651	---	June 15	---	Sept. 15	Statewide
North Dakota	1,400	---	June 20	---	Sept. 25	Statewide
South Dakota	2,092	---	June 5	---	Sept. 20	Statewide
Nebraska	1,831	---	June 5	---	Sept. 30	1, 2, 3, 5, 6, 9
Kansas	1,201	---	May 15	---	Oct. 15	Statewide
Delaware	6	---	May 25	---	Sept. 25	Statewide
Maryland	92	---	May 20	---	Sept. 25	Statewide
Virginia	250	---	May 1	---	Oct. 20	2, 4, 7
West Virginia	127	---	May 25	---	Sept. 10	Statewide
North Carolina	39	---	May 25	---	Sept. 30	1, 2, 4, 5, 8
Georgia	16	---	May 1	---	Sept. 15	1, 2, 3, 4, 5
Kentucky	330	---	May 15	---	Sept. 15	2, 3, 4, 5
Tennessee	177	---	May 1	---	Oct. 1	4, 5, 6
Alabama	16	---	May 1	---	Sept. 15	1, 2, 2a, 3, 4, 5, 6
Mississippi	9	---	May 15	---	Sept. 30	1, 3, 4, 6
Arkansas	42	---	May 15	---	Sept. 15	Statewide
Louisiana	16	---	Apr. 1	---	Oct. 15	1
Oklahoma	418	---	Apr. 20	---	Oct. 20	Statewide
Texas	155	---	May 1	---	Sept. 30	1n, 2n, 4, 6, 9
Montana	1,017	---	June 10	---	Sept. 20	Statewide
Idaho	959	---	June 5	---	Oct. 15	Statewide
Wyoming	468	---	June 10	---	Sept. 5	1, 2, 3, 5
Colorado	845	---	June 10	---	Sept. 25	Statewide
New Mexico	156	---	May 1	---	Oct. 20	1, 3, 7, 9
Arizona	210	---	Mar. 15	---	Dec. 1	5, 7
Utah	443	---	May 15	---	Oct. 25	Statewide
Nevada	122	---	May 15	---	Oct. 1	Churchill, Lyon, Pershing, Douglas, Elko
Washington	427	---	June 1	---	Sept. 15	Statewide
Oregon	360	---	May 5	---	Sept. 15	Statewide
California	1,156	---	Apr. 15	---	Nov. 5	5a, Imperial

Hay--Clover and Timothy

The major producing areas for clover and timothy hay are in the North Central and Northeastern States. In 1962, the North Central States harvested 7.2 million acres and the Northeastern States harvested 3.8 million acres of clover and timothy or clover mixtures of hay. More than three-fourths of the Nation's total clover and timothy acreage was located in these two regions.

The clover and timothy hay crop was formerly much more important than it is today. In 1909, nearly 37 million acres of clover and timothy were cut, compared with 4.7 million acres of alfalfa hay. In 1962, only 14.4 million acres of clover and timothy hay were cut, compared with 28.4 million acres of alfalfa. Part of the decline in the acreage of clover and timothy is associated with the decrease in number of horses used as draft animals.

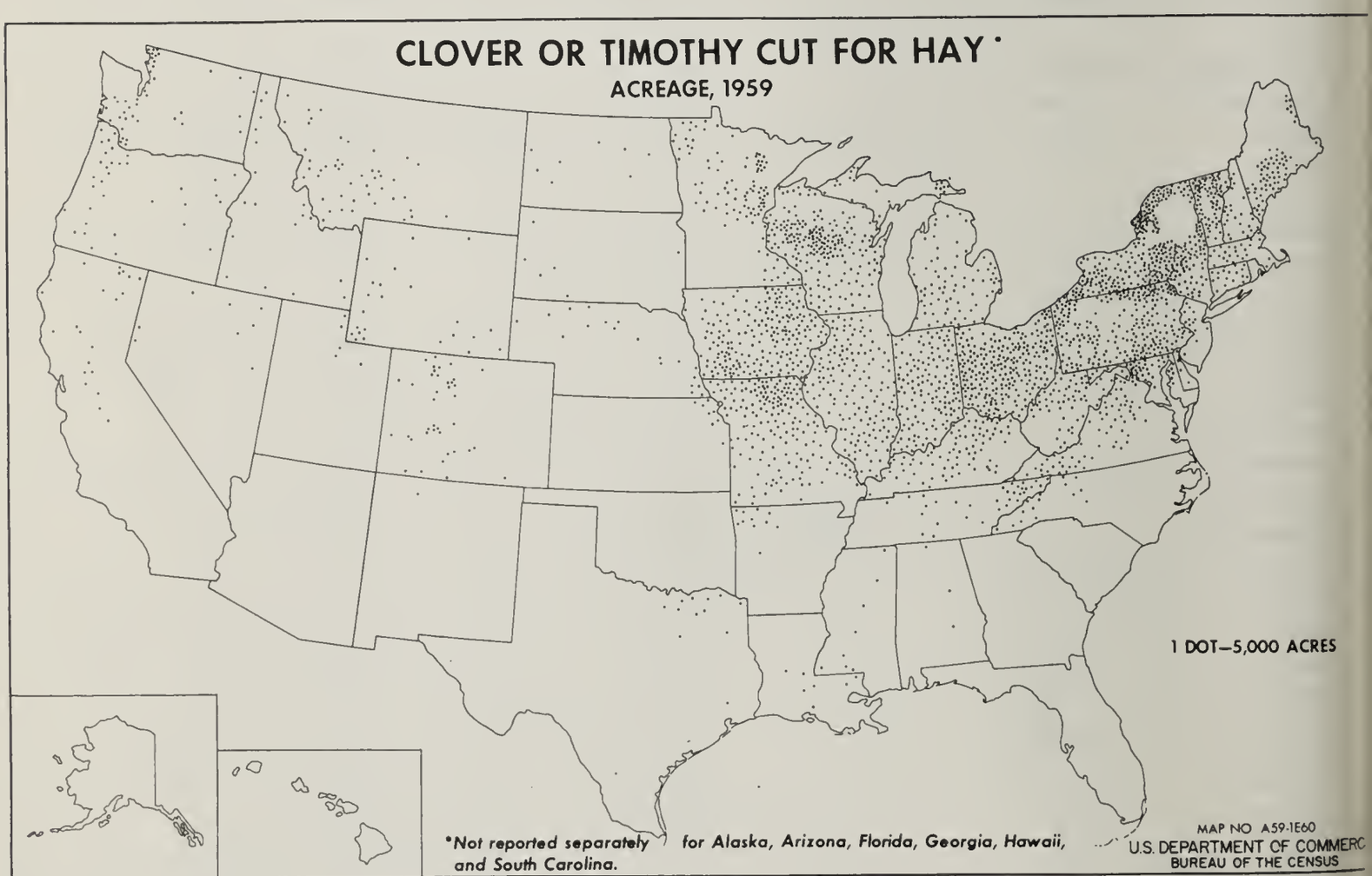


Figure 13

Table 6.--Hay, Clover-Timothy: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Maine	334	---	June 20	---	Aug. 20	Statewide
New Hampshire	107	---	June 20	---	Aug. 20	Statewide
Vermont	383	---	June 20	---	Aug. 20	Statewide
Massachusetts	131	---	June 10	---	Aug. 15	Statewide
Rhode Island	11	---	June 10	---	Aug. 15	Statewide
Connecticut	90	---	June 10	---	Aug. 15	Statewide
New York	1,508	---	June 10	---	Sept. 5	Statewide
New Jersey	70	---	June 5	---	Sept. 20	Statewide
Pennsylvania	1,171	---	June 5	---	Sept. 25	Statewide
Ohio	1,043	---	June 5	---	Sept. 1	Statewide
Indiana	629	---	June 10	---	Sept. 15	Statewide
Illinois	855	---	May 30	---	July 15	Statewide
Michigan	466	---	June 15	---	July 10	Statewide
Wisconsin	901	---	June 15	---	Sept. 10	Statewide
Minnesota	532	---	June 20	---	Aug. 30	Statewide
Iowa	1,231	---	June 10	---	Sept. 10	Statewide
Missouri	1,396	---	June 1	---	Aug. 20	Statewide
Nebraska	75	---	June 20	---	Aug. 15	3, 6, 9
Kansas	104	---	June 1	---	Aug. 25	3, 6, 9
Delaware	20	---	June 1	---	Sept. 1	Statewide
Maryland	212	---	June 1	---	Sept. 1	Statewide
Virginia	483	---	May 25	---	Aug. 10	2, 4, 5, 7
West Virginia	341	---	June 1	---	Aug. 30	Statewide
North Carolina	152	---	June 5	---	Aug. 20	1, 2, 4, 5
Kentucky	466	---	June 5	---	Aug. 15	2, 3, 5, 6
Tennessee	235	---	May 1	---	June 20	3, 4, 5, 6
Alabama	32	---	May 10	---	Oct. 1	Statewide
Mississippi	58	---	May 20	---	July 31	5, 7, 8
Arkansas	92	---	June 1	---	Aug. 1	Statewide
Montana	270	---	June 25	---	Sept. 15	Statewide
Idaho	118	---	June 20	---	Sept. 1	Statewide
Wyoming	130	---	July 1	---	Aug. 15	1, 2, 3, 5
Colorado	222	---	July 10	---	Aug. 25	1
New Mexico	15	---	July 1	---	Aug. 15	1, 3
Utah	43	---	July 1	---	Aug. 31	6
Nevada	48	---	July 1	---	Sept. 1	Elko, Washoe, Douglas, Humbolt
Washington	229	---	May 25	---	Sept. 5	Statewide
Oregon	184	---	June 5	---	Aug. 15	1, 7
Alaska	5.1	---	June 15	---	Oct. 15	Tanana, Matanuska Valleys

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Oats

Oats, the second major small grain produced in the United States is most important as a feed for livestock. In 1962, almost 23 million acres were harvested, producing over 1 billion bushels of grain. Minnesota and Iowa are the leading producing States; but the crop is also grown extensively throughout the Corn Belt, Great Lakes States, and the Northern Plains. Acreage has shown a consistent decline in recent years, from 40 million acres harvested in 1954 to less than 23 million in 1962. Relatively few oats are produced in the southern and western parts of the United States.

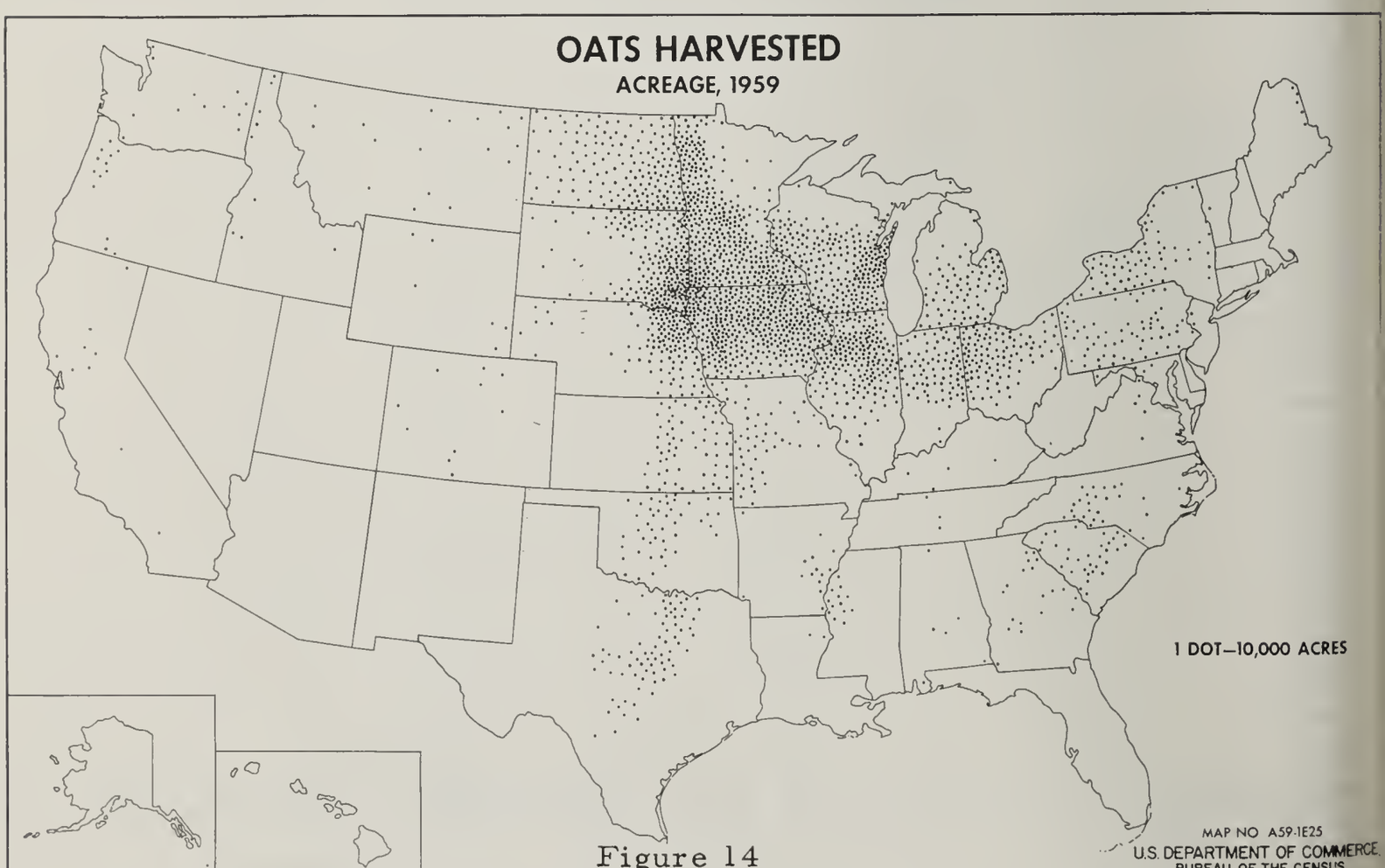


Figure 14

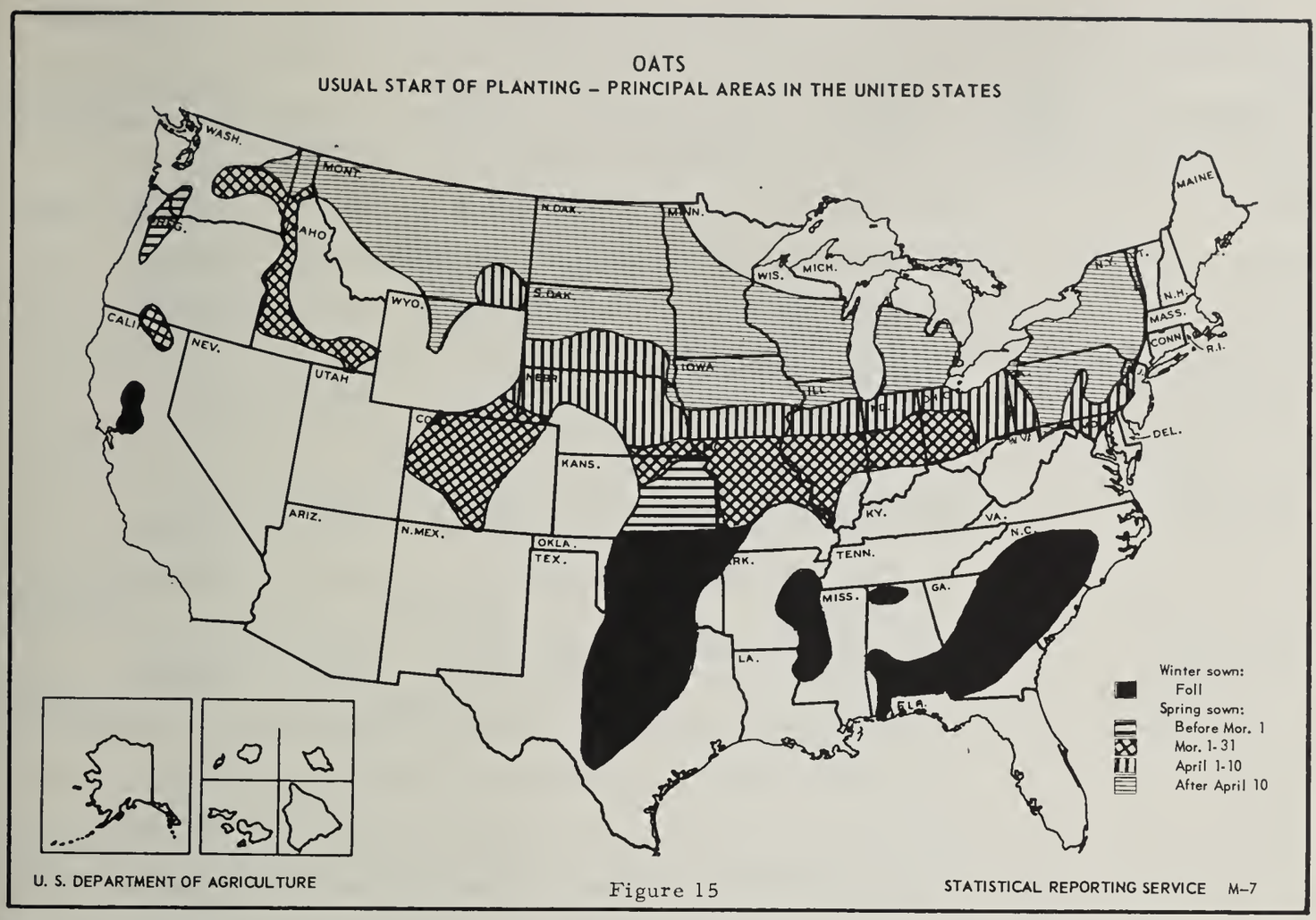


Figure 15

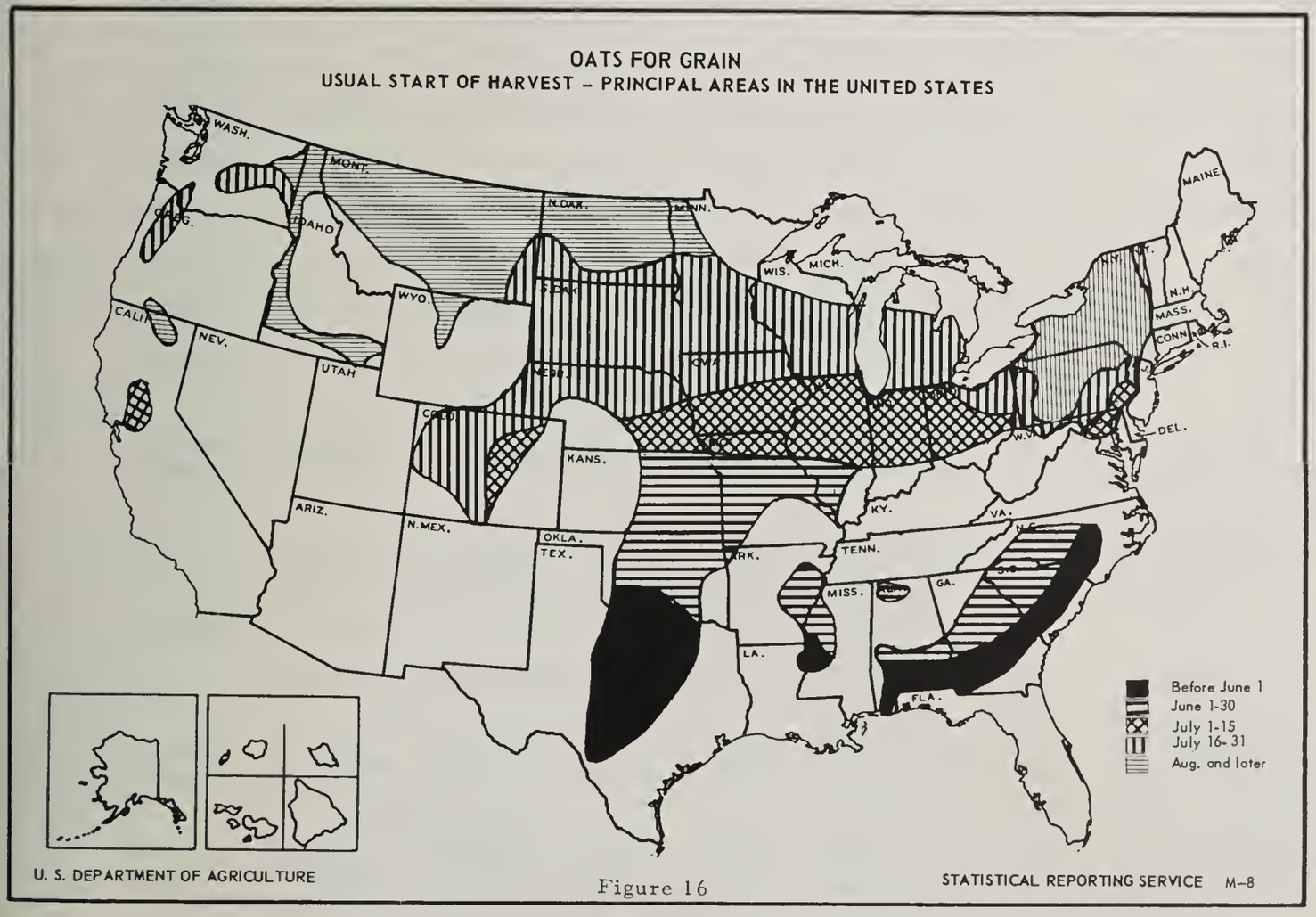


Figure 16

Table 7.--Oats: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Harvest dates			Principal producing areas and counties
			Begins	Most active	Ends	
Maine	49	May 10-June 10	Aug. 25	Sept. 5-Sept. 20	Oct. 1	Aroostook, Penobscot
Vermont	14	Apr.25-June 5	Aug. 1	Aug. 10-Aug. 25	Sept. 1	Statewide
New York	569	Apr.20-May 25	Aug. 1	Aug. 10-Aug. 25	Sept. 10	Statewide
New Jersey						
Fall sown	18	Sept.20-Oct. 10	July 15	July 20-Aug. 10	Aug. 30	5, 8
Spring sown		Mar.15-Apr. 25	July 15	July 20-Aug. 10	Aug. 20	2
Pennsylvania						
Fall sown	601	Sept. 1-Sept.20	July 10	July 20-Aug. 1	Aug. 10	9
Spring sown		Apr.10-May 25	July 25	Aug. 1-Aug. 20	Sept. 1	Statewide
Ohio	833	Apr. 1-May 5	July 10	July 20-Aug. 5	Aug. 15	Statewide
Indiana						
Fall sown	605	Sept. 1-Sept.30	June 20	June 25-July 5	July 10	7, 8, 9
Spring sown		Apr. 1-Apr. 25	July 1	July 10-July 30	Aug. 5	Statewide
Illinois	1,503	Mar.25-Apr. 30	July 5	July 15-July 30	Aug. 5	1, 3, 4, 5, 6
Michigan	754	Apr.10-May 15	July 20	July 25-Aug. 20	Aug. 25	Statewide
Wisconsin	2,229	Apr.10-May 10	July 15	July 20-July 30	Aug. 15	Statewide
Minnesota	3,026	Apr.15-May 20	July 20	Aug. 2-Aug. 16	Aug. 30	Statewide
Iowa	2,947	Apr. 1-May 1	July 10	July 20-July 30	Aug. 10	Statewide
Missouri						
Fall sown	316	Sept. 1-Sept. 30	June 5	June 10-June 20	June 25	7, 8, 9
Spring sown		Mar. 1-Apr. 15	June 15	June 20-July 10	July 15	Statewide
North Dakota	1,950	Apr.15-June 1	July 25	Aug. 1-Aug. 15	Aug. 25	Statewide
South Dakota	2,590	Apr. 5-May 5	July 15	July 25-Aug. 5	Aug. 10	2, 3, 5, 6, 9
Nebraska	971	Apr. 5-May 1	July 10	July 15-Aug. 1	Aug. 15	3, 6, 9
Kansas	351	Feb.15-May 1	June 20	June 25-July 10	July 20	Statewide
Delaware	6	Sept.20-Nov. 10	June 15	June 25-July 10	July 20	Statewide
Maryland						
Fall sown	50	Sept.20-Nov. 10	June 15	June 25-July 10	July 25	Statewide
Spring sown		Mar.20-May 1	June 25	July 5-July 25	Aug. 5	Statewide
Virginia						
Fall sown	81	Sept. 1-Oct. 25	June 1	June 10-July 1	July 10	5, 6, 8, 9
Spring sown		Feb. 1-Apr. 15	June 15	July 1-July 15	July 20	2, 4, 7, 8
West Virginia	24	Apr.10-May 20	July 15	July 25-Aug. 10	Aug. 20	Statewide
North Carolina	217	Sept.20-Oct. 30	May 25	June 10-June 25	July 5	2, 5, 8, 9
South Carolina						
Fall sown	199	Oct. 1-Dec. 1	May 20	May 25-June 15	June 20	Statewide
Spring sown		Jan.15-Mar. 1	June 5	June 10-June 25	July 1	Statewide
Georgia						
Fall sown	139	Oct. 1-Dec. 1	May 10	May 25-June 10	June 20	Statewide
Spring sown		Jan.15-Mar. 1	May 25	June 5-June 20	July 1	Statewide

Table 7.--Oats: Usual planting and harvesting dates by States and principal producing areas--Con.

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Florida	15	Sept.15 - Nov. 1	Apr. 20	May 1-May 10	May 30	1, 3, 5
Kentucky						
Fall sown	43	Aug. 25 - Sept.30	June 15	June 20-July 5	July 15	1, 2, 3
Spring sown		Mar. 1 - Apr. 15	June 25	July 1-July 15	July 25	3, 5, 6
Tennessee						
Fall sown	85	Sept.1 - Nov. 1	June 1	June 10-June 30	July 5	Statewide
Spring sown		Mar. 15 - Apr. 15	Mostly for hay			4, 5, 6
Alabama	83	Sept.1 - Dec. 1	May 20	June 1-June 20	July 1	Statewide
Mississippi						
Fall sown	132	Sept.25 - Nov. 5	May 20	June 1-June 10	June 20	1, 4
Spring sown		Feb. 15 - Mar. 15	June 1	June 10-June 20	June 30	Statewide
Arkansas						
Fall sown	106	Sept.15 - Nov. 15	June 1	June 5-June 20	June 30	Statewide
Spring sown		Feb. 15 - Mar. 15	June 10	June 15-July 1	July 5	Statewide
Louisiana	38	Sept.15 - Oct. 30	May 10	May 20-June 10	June 15	1, 3, 5, 6, 7
Oklahoma						
Fall sown	319	Sept.10 - Nov. 10	June 1	June 10-June 22	July 5	Statewide
Spring sown		Jan. 25 - Mar. 15	June 1	June 10-June 22	July 5	Statewide
Texas	741	Sept.10 - Nov. 25	May 10	May 20-June 15	June 25	2s, 3, 4, 7, 8n
Montana	263	Apr. 5 - June 1	Aug. 1	Aug. 10-Sept.1	Sept.15	Statewide
Idaho	141	Mar. 25 - May 25	Aug. 1	Aug. 10-Sept.20	Oct. 10	Statewide
Wyoming	94	Apr. 5 - May 20	Aug. 1	Aug. 10-Aug. 25	Aug. 30	1, 2, 5
Colorado	101	Mar. 15 - Apr. 25	July 1	July 10-Aug. 15	Aug. 30	Statewide
New Mexico						
Fall sown	9	Sept.1 - Oct. 15	June 15	June 20-July 5	July 15	1, 3, 9
Spring sown		Feb. 15 - Apr. 15	July 1	July 5-July 25	Aug. 15	1, 3, 9
Arizona						
Fall sown	7	Oct. 1 - Nov. 20	May 5	May 25-June 15	June 20	5
Spring sown		Mar. 15 - Apr. 30	Aug. 1	Aug. 20-Sept.5	Sept.15	2
Utah	26	Mar. 20 - May 10	Aug. 1	Aug. 15-Sept.15	Sept.25	Box Elder, Cache, Duchesne, Sanpete, Uintah, Utah, Weber
Nevada	3	Apr. 20 - May 10	July 20	July 25-Aug. 20	Sept.1	Douglas, Humbolt, Lyon, Nye
Washington	105	Mar. 10 - Apr. 20	July 15	Aug. 1-Aug. 25	Sept.10	Statewide
Oregon						
Fall sown	169	Oct. 5 - Feb. 15	July 10	July 25-Aug. 15	Aug. 31	Statewide
Spring sown		Feb. 15 - Apr. 15	Aug. 10	Aug. 20-Sept.1	Sept.10	Statewide
California						
Fall sown	153	Nov. 1 - Mar. 1	July 1	July 15-July 30	Aug. 15	Sonoma, Butte, Sutter, Solano, Sacramento
Spring sown		Mar. 15 - May 10	Aug. 25	Sept. 1-Sept. 20	Sept.30	Modoc, Siskiyou
Alaska	11	Apr. 25 - July 5	Sept.15	Sept.25-Oct. 10	Oct. 20	Tanana & Matanuska Valleys

Peanuts For Nuts

Production of peanuts is confined mostly to Southern States. There are three main producing areas -- the Virginia-Carolina area, where large seeded bunch and runner types predominate; the Southeast, where the crop is mainly small seeded runners and Spanish types; and the Southwest, where the acreage is almost exclusively planted to Spanish types. Some acreage of Valencias--a roasting type--is planted in New Mexico. The leading producing States in order of importance in 1962 were Georgia, North Carolina, Virginia, Texas, Alabama, and Oklahoma. The acreage harvested for nuts has been fairly stable in recent years.

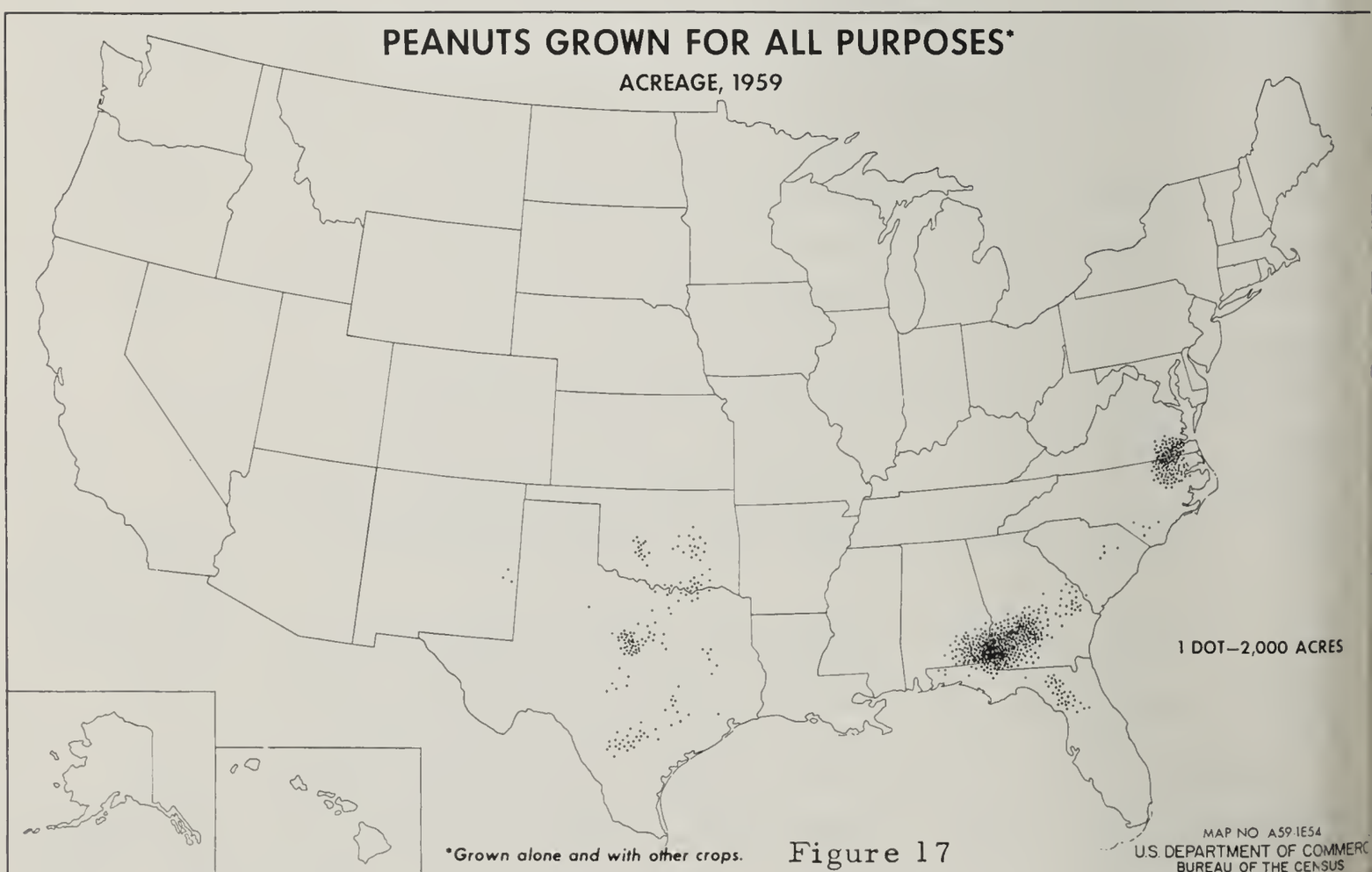


Figure 17

Table 8.--Peanuts for Nuts: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Virginia	104	May 5-June 5	Sept. 20	Oct.1-Nov. 25	Dec. 10	9
North Carolina	176	May 1-June 5	Sept. 15	Oct.1-Oct. 20	Nov. 15	3, 6, 9
South Carolina	11	Apr.15-May 20	Sept. 1	Sept.15-Oct.1	Oct. 15	Sumter, Lee, Florence, Hampton, Barnwell, Aiken
Georgia	472	Apr.10-May 20	Aug. 15	Aug.15-Sept.15	Oct. 15	4, 5, 6, 7, 8
Florida	48	Apr. 1-Apr.30	Aug. 20	Sept.1-Oct.15	Oct. 25	Jackson, Santa Rosa, Holmes, Calhoun, Levy, Marion
Alabama	195	Apr.15-May 15	Aug. 25	Sept.15-Oct.5	Oct. 25	9, Covington, Crenshaw
Mississippi	5	Apr.15-May 25	Aug. 20	Sept.5-Sept.20	Oct. 10	5, 6, 7, 9
Oklahoma	115	May 10-June 15	Sept. 20	Oct.5-Nov. 15	Dec. 1	5, 6, 7, 8, 9
Texas	287	Apr. 1-Aug. 1	July 15	Sept.1-Nov.15	Dec. 15	3, 4, 8n, 10n
New Mexico	7.5	May 10-June 1	Oct. 1	Oct.10-Oct.25	Nov. 10	Roosevelt

Table 9.--Rice: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Missouri	4.6	May 1-May 20	Oct. 1	Oct. 5-Oct. 25	Oct. 30	Marion, St. Charles, Lincoln, Lewis, Scott, Stoddard, Pemiscot, Butler, New Madrid, Dunklin, Ripley
Mississippi	49	Apr.15-May 31	Sept.10	Oct. 1-Oct. 15	Nov. 15	1, 4
Arkansas	426	Apr.20-May 25	Sept.20	Oct. 1-Oct. 20	Nov. 1	3, 6, 9
Louisiana	508	Apr.10-May 31	Aug.10	Sept.1-Oct. 1	Oct. 15	3, 5, 7, 8
Texas	462	Mar.25-June 1	July 15	Aug.10-Sept.15	Nov. 15	9
California	323	Apr. 1-June 1	Sept.15	Oct.10-Oct. 30	Nov. 30	5, Fresno

Successful rice culture is dependent upon high temperatures during the growing season, a dependable fresh water supply for the irrigation period, soils that are comparatively level and underlain with impervious subsoil, and good drainage. Areas which meet these requirements are the Coastal Prairie region of southwestern Louisiana and southeastern Texas, eastern Arkansas and northwest Mississippi, and the central valleys of California (particularly the Sacramento Valley). Production in the United States is confined mainly to these three regions.

The acreage of rice harvested in 1962 totaled 1.8 million acres, the largest since 1955. The peak year came in 1954, when 2.6 million acres were harvested. The average yield per acre has increased sharply in recent years, averaging 3,726 pounds per acre in 1962 and pushing production to a record level. The average yield for the previous 5 years was 3,317 pounds per acre.

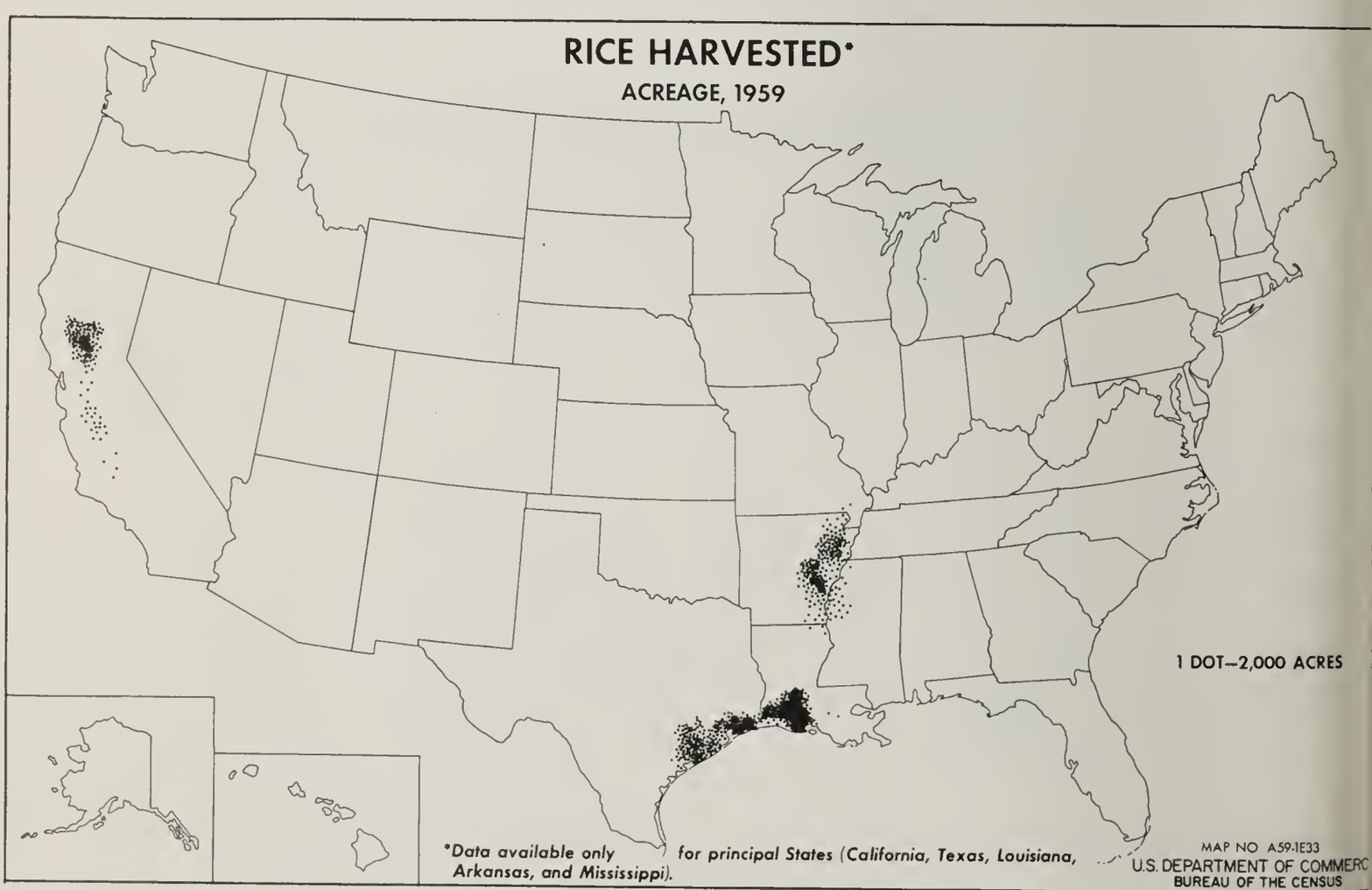


Figure 18

Rye

Rye was harvested from 2.0 million acres in 1962, the largest since 955. However, this was well below the peak in 1919, when 7.2 million cres were harvested. It should be noted that a large acreage of rye, in ddition to the acreage harvested for grain, is used as a winter cover crop. 'his often serves as pasture and then is turned under as a green manure rop. In 1962, only 41 percent of the acres planted were harvested for grain.

Rye is usually planted in the fall and harvested during the late spring and arly summer months. Most of the rye is produced in the Northern and the :entral Plains. Four States--North Dakota, South Dakota, Nebraska, and :ansas--had 61 percent of the 1962 harvested acreage. Only minor acreages f rye are grown in the eastern and southern parts of the United States.

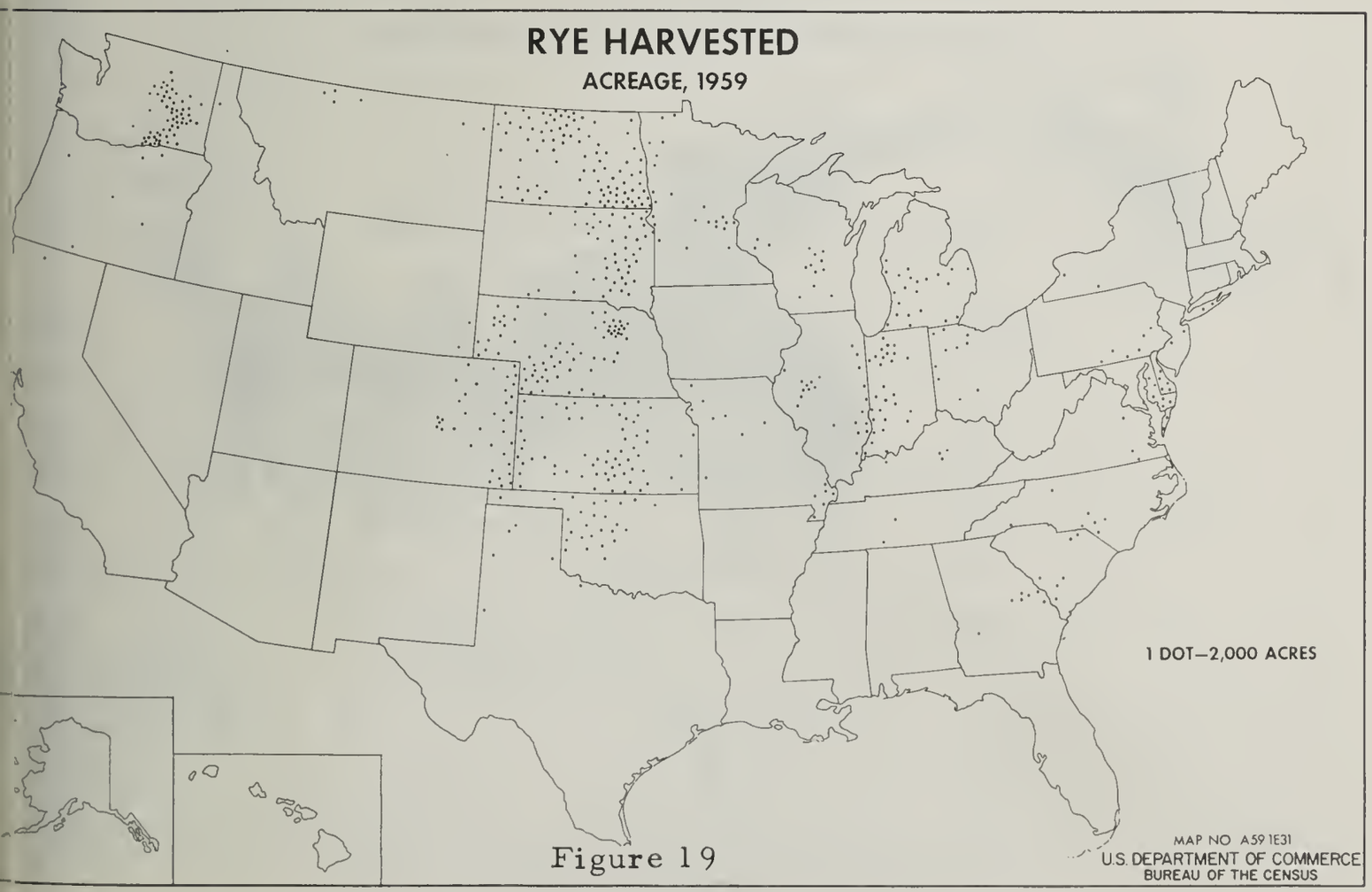
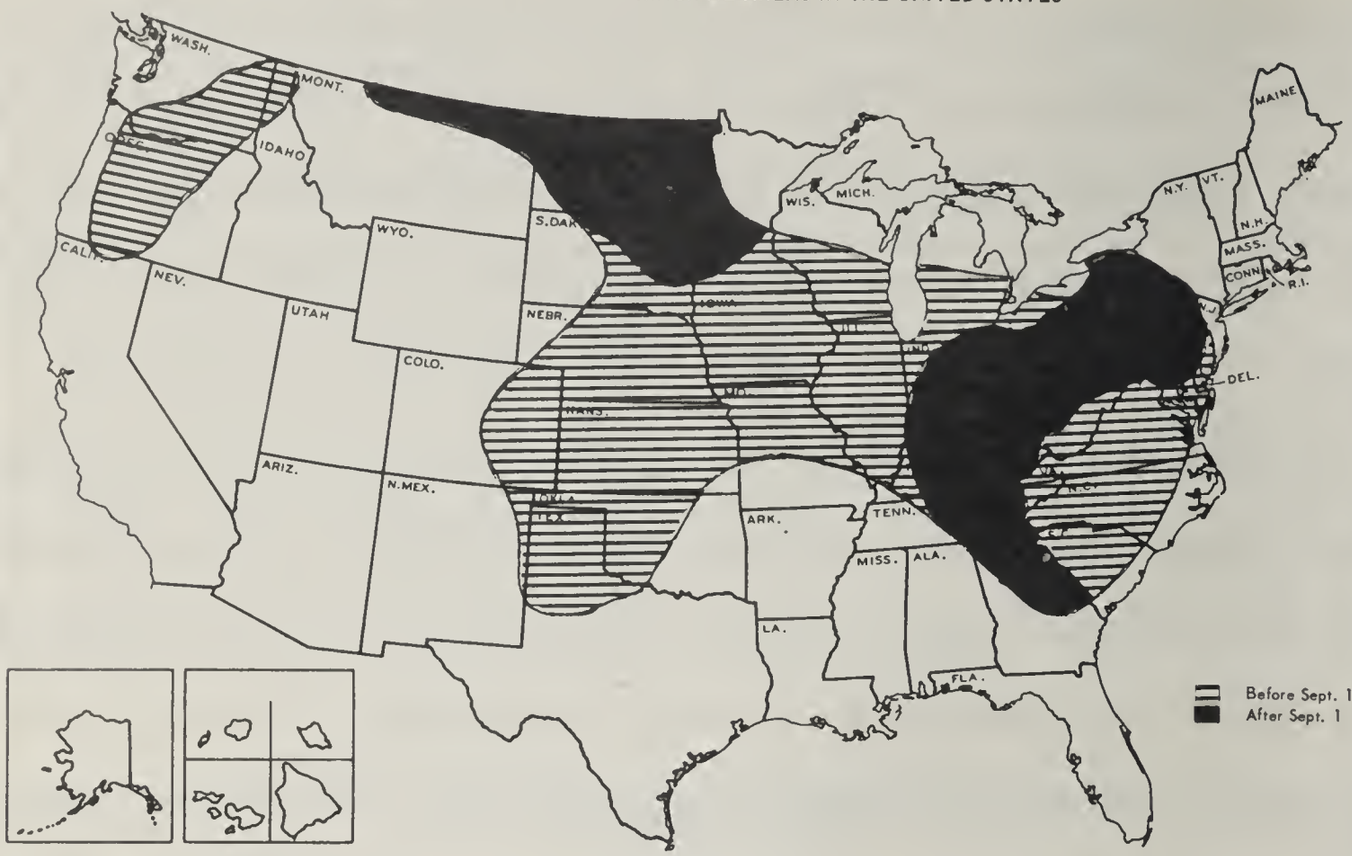


Figure 19

764-744 O-65—4

RYE

USUAL START OF PLANTING – PRINCIPAL AREAS IN THE UNITED STATES



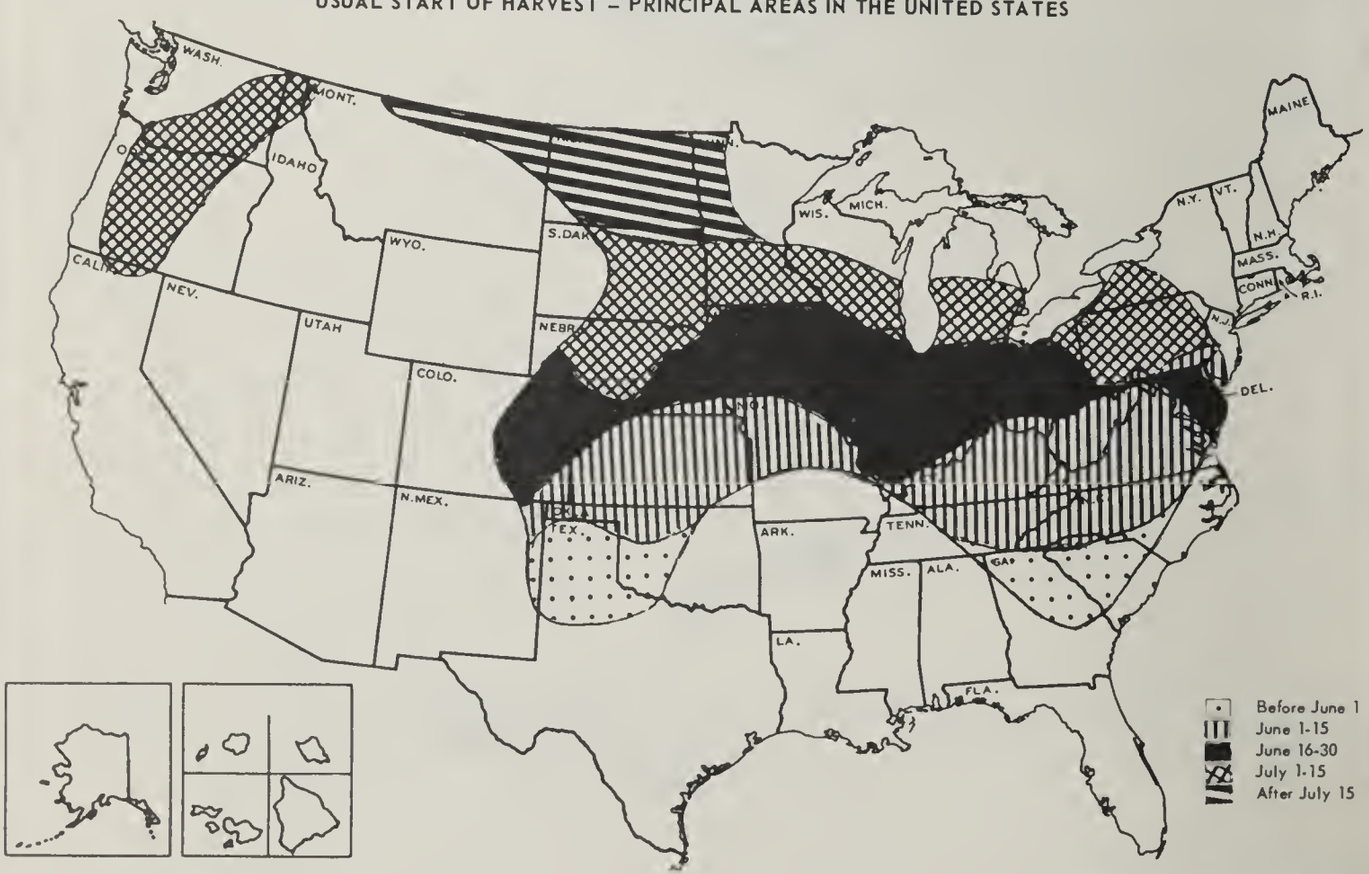
U. S. DEPARTMENT OF AGRICULTURE

Figure 20

STATISTICAL REPORTING SERVICE M–9

RYE FOR GRAIN

USUAL START OF HARVEST – PRINCIPAL AREAS IN THE UNITED STATES



U. S. DEPARTMENT OF AGRICULTURE

Figure 21

STATISTICAL REPORTING SERVICE M–10

Table 10.--Rye: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
New York	19	Aug. 20-Oct. 10	July 1	July 5-July 15	July 20	4, 9a
New Jersey	10	Sept. 1-Oct. 15	July 5	July 15-July 25	Aug. 5	2, 5, 8
Pennsylvania	18	Sept.15-Oct. 15	July 1	July 15-July 25	Aug. 10	Statewide
Ohio	31	Sept.10-Oct. 20	June 25	July 5-July 15	July 20	Statewide
Indiana	53	Sept.10-Oct. 15	June 15	June 20-July 15	July 20	Statewide
Illinois	55	Aug. 20-Sept.20	June 20	June 25-July 5	July 5	Statewide
Michigan	42	Aug. 15-Oct. 15	July 15	July 20-Aug. 1	Aug. 10	Statewide
Wisconsin	23	Sept. 5-Oct. 1	July 10	July 20-July 30	Aug. 10	Portage, Dunn, Waushara, Marquette, Adams
Minnesota	86	Sept. 1-Sept.25	July 20	July 27-Aug. 8	Aug. 15	1, 4, 5, 6
Iowa	5	Aug. 25-Sept.20	June 25	July 5-July 15	July 20	Statewide
Missouri	30	Aug. 15-Sept.30	June 1	June 10-June 25	June 30	Statewide
North Dakota	539	Sept. 1-Sept.20	July 20	July 25-Aug. 5	Aug. 15	Statewide
South Dakota	261	Sept. 1-Oct. 1	July 15	July 20-Aug. 1	Aug. 5	2, 3, 5, 6, 9
Nebraska	225	Aug. 15-Sept.20	June 25	July 1-Aug. 10	Aug. 15	1, 2, 3, 7
Kansas	189	Sept. 1-Oct. 1	June 5	June 10-June 25	July 1	Statewide
Delaware	10	Sept.25-Nov. 15	June 20	June 25-July 15	July 20	Statewide
Maryland	18	Sept.25-Nov. 15	June 20	June 25-July 15	July 25	Statewide
Virginia	19	Sept. 1-Dec. 1	June 1	June 15-July 1	July 5	6, 9
North Carolina	16	Aug. 20-Nov. 15	June 5	June 15-July 1	July 5	2, 5, 8, 9
South Carolina	16	Sept. 1-Dec. 5	May 25	June 1-June 15	June 20	Chesterfield, Orangeburg, Aiken, Bamberg, Hampton, Barnwell
Georgia	24	Sept.15-Nov. 15	May 15	June 1-June 15	July 1	Statewide
Kentucky	10	Sept.10-Oct. 15	June 15	June 25-July 10	July 15	2, 5
Tennessee	9	Sept. 1-Oct. 20	June 1	June 10-July 1	July 5	3, 4, 5
Oklahoma	58	Sept. 1-Oct. 15	June 5	June 10-June 20	July 1	1, 2, 4, 5, 7
Texas	23	Sept. 1-Nov. 20	May 10	June 1-June 15	June 25	1n, 1s, 2n, 2s
Montana	37	Aug. 20-Oct. 10	July 20	July 25-Aug. 15	Sept. 1	2, 3
Idaho	8	Sept.15-Sept.30	July 10	July 20-July 30	Aug. 5	Statewide
Wyoming	7	Aug. 20-Sept.30	July 20	July 30-Aug. 10	Aug. 15	5
Colorado	48	Aug. 25-Oct. 15	July 1	July 10-July 30	Aug. 15	2, 6, 9
Washington	81	Aug. 10-Nov. 1	July 5	July 20-Aug. 15	Sept. 1	2, 5
Oregon	17	Sept. 1-Feb. 1	July 10	July 15-Aug. 20	Aug. 30	Statewide

Sorghum

Sorghum is well adapted to heat and is tolerant to limited moisture conditions. For this reason, most grain sorghums are grown in the Southern Plains States. Of the 11.5 million acres harvested for grain in 1962, 84 percent was in Texas, Kansas, and Nebraska. Acreage fluctuated considerably from year to year but trended upward to a maximum of nearly 27 million acres planted in 1957. The Feed Grain Program effective in 1961 sharply reduced the acreage. With the introduction of hybrid seed in 1956 sorghum yields surged upwards and by 1962 had doubled the prehybrid yield level. Sorghum grain is used primarily as a livestock feed.

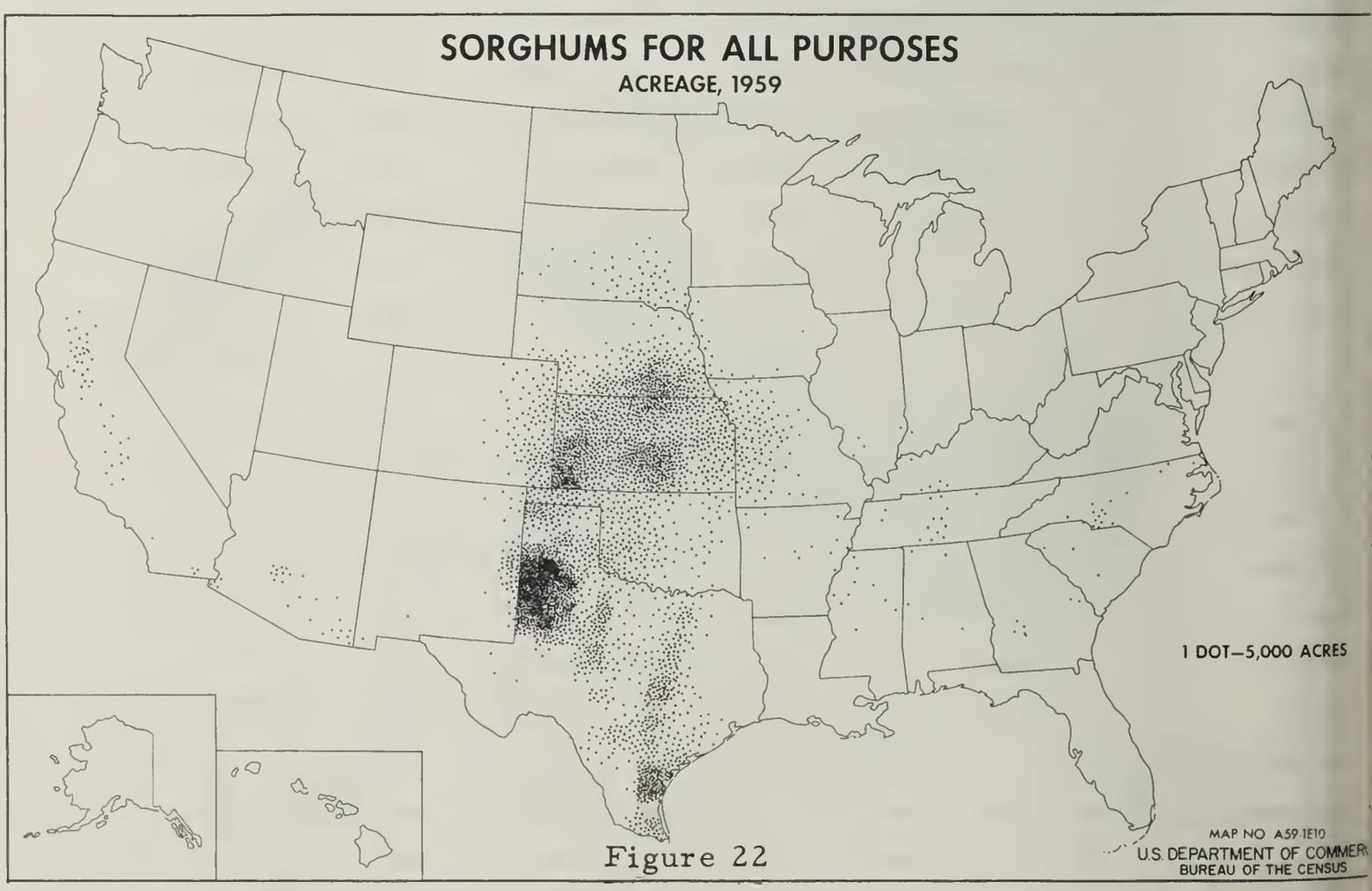


Figure 22

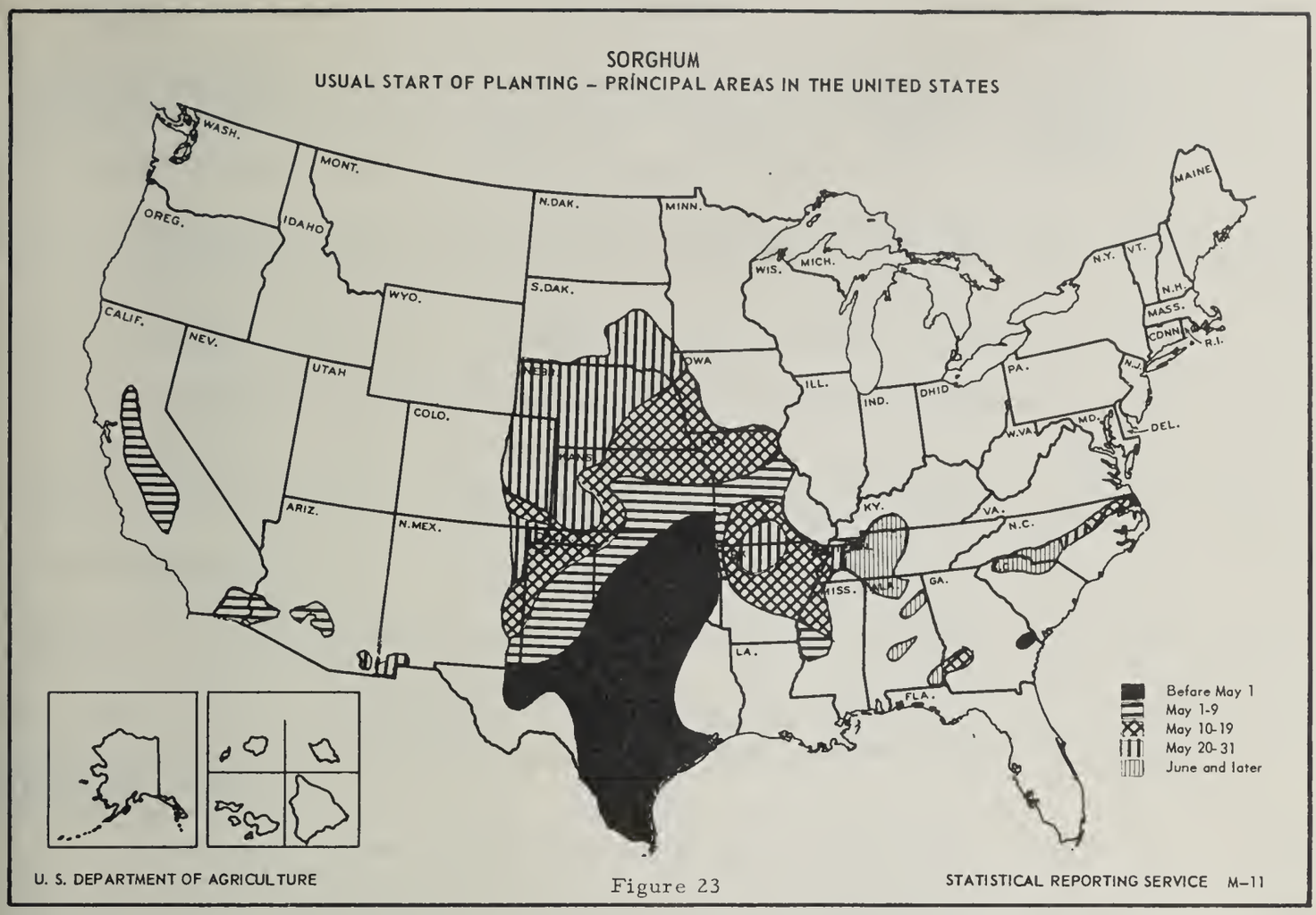


Figure 23

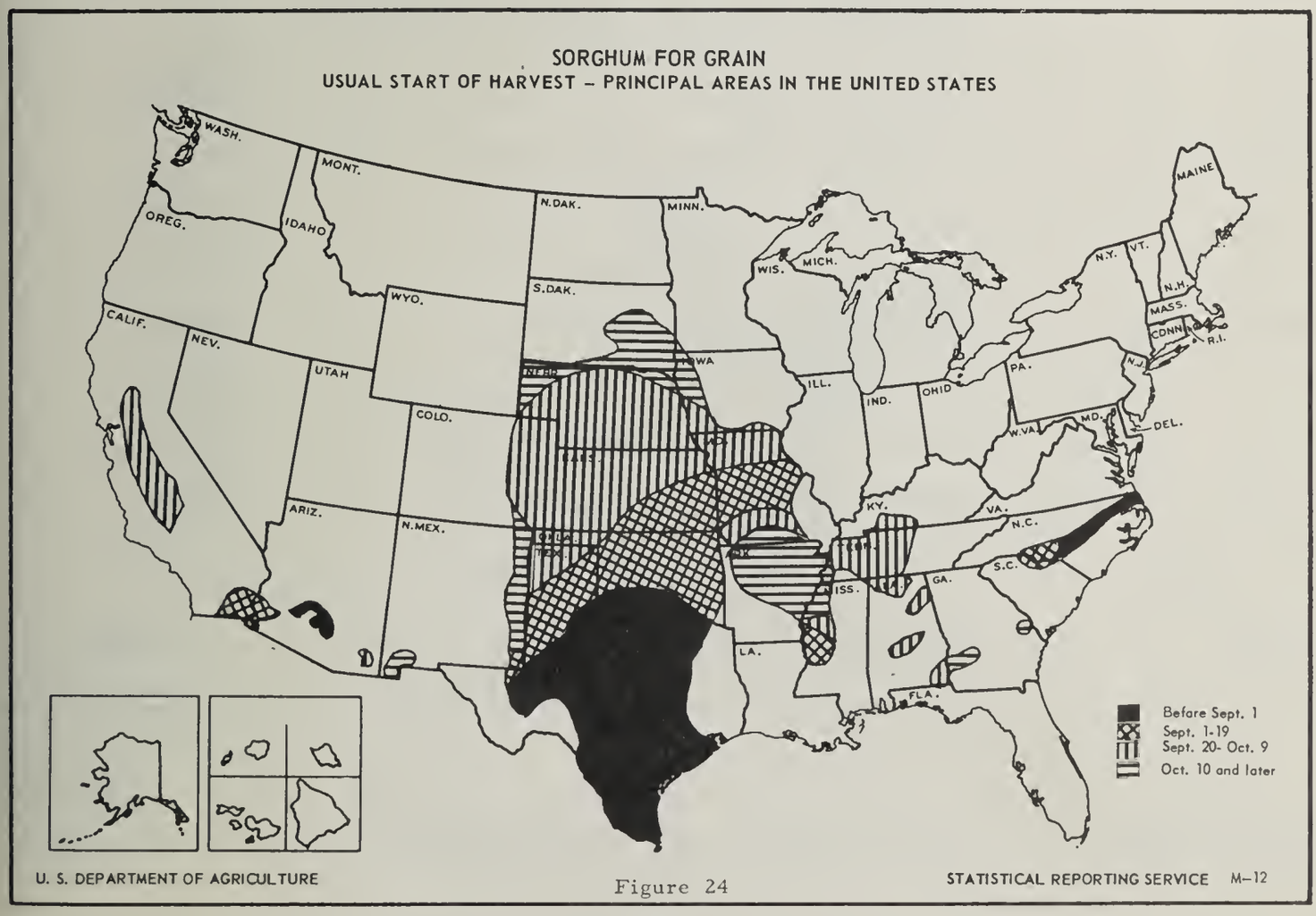


Figure 24

Table 11.--Sorghum: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Indiana	11	May 5-June 5	Sept.25	Sept.30-Oct. 10	Oct. 15	Statewide
Illinois	6	May 10-June 20	Oct. 10	Oct. 20-Nov. 20	Dec. 10	4a, 6a, 7
Iowa	12	May 10-June 10	Oct. 5	Oct. 20-Nov. 5	Nov. 15	Statewide
Missouri	177	May 15-June 15	Sept.15	Sept.25-Oct. 20	Oct. 30	Statewide
South Dakota	115	May 20-June 20	Oct. 1	Oct. 10-Oct. 25	Nov. 5	5, 6, 8, 9
Nebraska	1,540	May 15-June 15	Oct. 10	Oct. 20-Nov. 5	Nov. 20	5, 6, 7, 8, 9
Kansas	2,960	May 10-July 1	Sept.25	Oct. 10-Nov. 10	Dec. 1	Statewide
Virginia	7	May 10-July 1	Sept.25	Oct. 1-Nov. 5	Nov. 25	9
North Carolina	48	May 1-July 1	Aug. 15	Sept. 5-Sept.30	Oct. 15	5, 8
South Carolina	6	June 1-Jan. 25	Sept.20	Sept.25-Oct. 25	Nov. 15	Newberry, Anderson, Saluda, Chester, Spartanburg, Greenville
Georgia	10	May 1-July 1	Oct. 15	Oct. 25-Nov. 10	Dec. 1	Statewide
Kentucky	10	May 1-June 10	Oct. 1	Oct. 15-Nov. 1	Nov. 10	2, 3
Tennessee	20	June 1-June 30	Sept.10	Sept.20-Oct. 15	Nov. 1	1, 2, 3, 4, 5
Alabama	10	June 1-July 15	Sept.25	Oct. 5-Nov. 1	Nov. 25	Statewide
Mississippi	6	May 1-June 30	Sept.15	Oct. 15-Nov. 15	Nov. 30	1, 4
Arkansas	12	May 1-June 15	Oct. 10	Oct. 15-Nov. 1	Nov. 5	Statewide
Louisiana	4	May 15-June 30	Aug. 15	Sept. 1-Oct. 1	Oct. 15	3, 7
Oklahoma	658	Apr.25-June 25	Aug. 25	Sept.20-Nov. 5	Dec. 5	Statewide
Texas	5,154	Mar.10-July 1	July 1	July 25-Nov. 1	Dec. 1	Statewide
Colorado	278	May 10-June 15	Sept.15	Oct. 1-Nov. 1	Nov. 10	6, 9
New Mexico	188	May 10-July 10	Oct. 1	Oct. 10-Nov. 10	Dec. 1	3, 7, 9
Arizona, early late	98	May 1-July 1	July 15 Oct. 1	July 20-Aug. 5 Oct. 20-Nov. 25	Aug. 10 Dec. 15	5, 7, 9
California	206	May 1-Aug. 1	Sept.15	Oct. 1-Nov. 10	Nov. 25	5, 5a, Imperial

Soybeans

Soybean production has been increasing at a phenomenal rate in the United States, more than doubling during the past decade. Soybeans are grown primarily for beans which are processed for oil and meal, although a small acreage is grown as a forage or green manure crop in some areas. The main soybean-producing area is in the North Central States, although the South Central and South Atlantic States are becoming increasingly important producers. Illinois is the leading State followed by Iowa. These two States accounted for nearly two-fifths of the U. S. total production in 1962. Other top-ranking States include Indiana, Missouri, Arkansas, Minnesota, and Ohio.

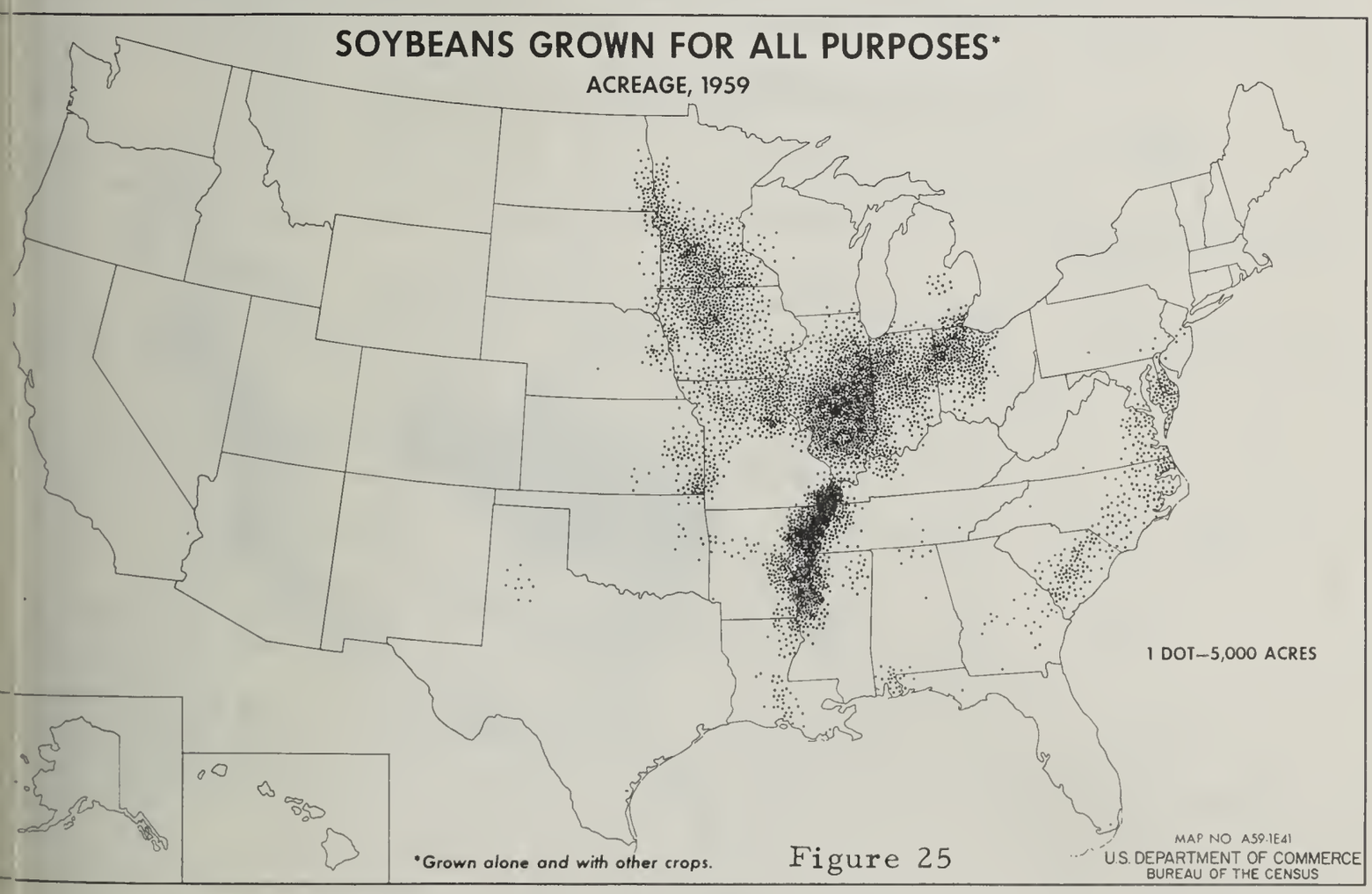


Figure 25

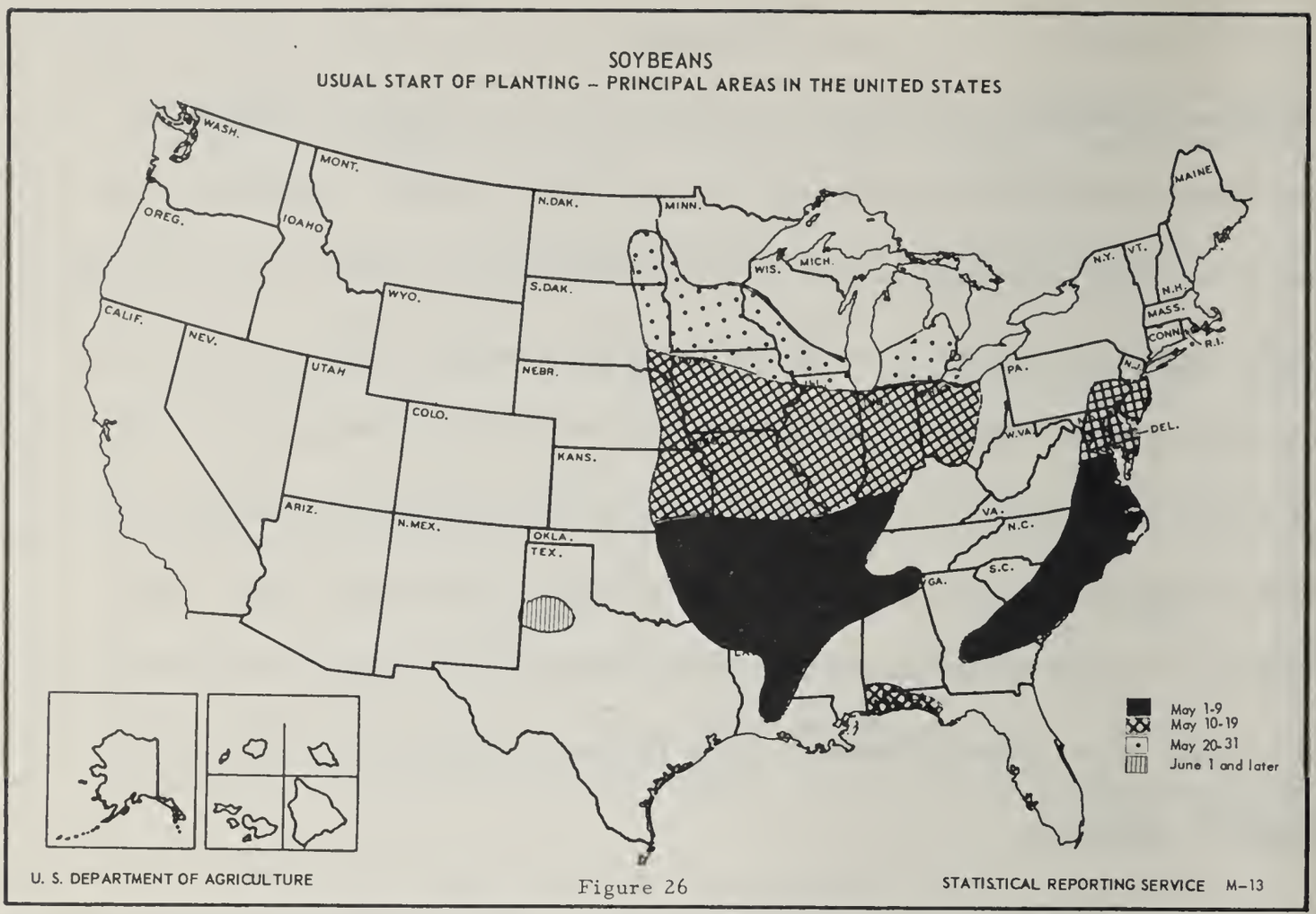


Figure 26

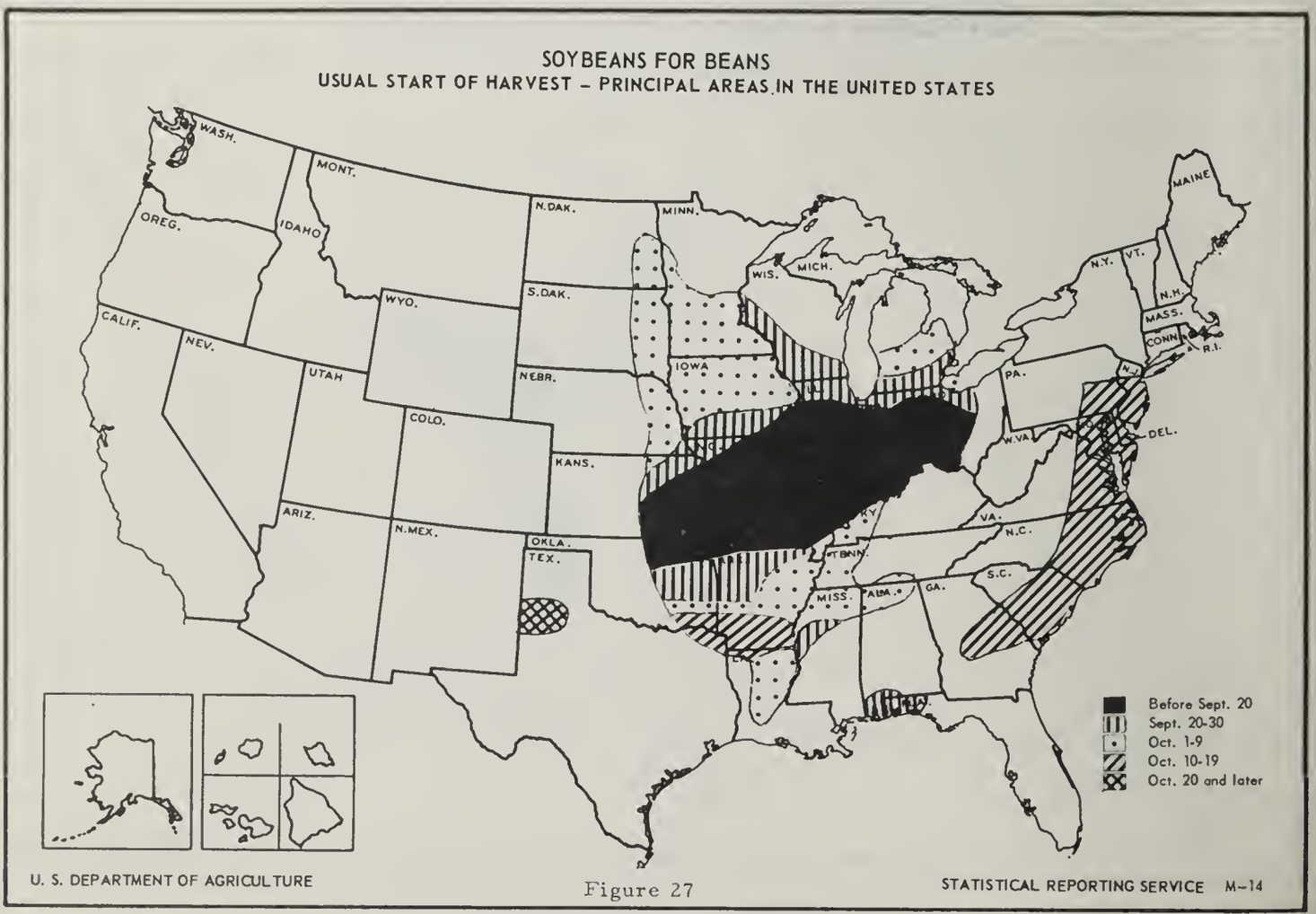


Figure 27

Table 12.--Soybeans: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
New York	4	June 1-June 30	Oct. 11	Oct. 10-Oct. 20	Oct. 30	Seneca
New Jersey	42	May 25-July 10	Oct. 20	Oct. 25-Nov. 10	Nov. 20	5, 8
Pennsylvania	9	May 15-July 1	Oct. 20	Nov. 1-Nov. 20	Dec. 1	9, Northampton, Northumberland, Montour
Ohio	1,791	May 10-June 10	Sept.20	Oct. 1-Oct. 15	Nov. 1	1, 2, 4, 5, 7, 8
Indiana	2,708	May 10-June 20	Sept.10	Sept.20-Oct. 20	Oct. 30	Statewide
Illinois	5,575	May 10-June 30	Sept.15	Sept.25-Oct. 10	Oct. 30	Statewide
Michigan	351	May 20-June 20	Sept.25	Oct. 5-Oct. 25	Nov. 1	5, 6, 7, 8, 9
Wisconsin	101	May 20-July 1	Sept.25	Oct. 5-Oct. 20	Nov. 1	Dunn, Trempealeau, Pepin, Eau Claire, Racine, Walworth, Kenosha
Minnesota	2,201	May 15-June 10	Sept.20	Oct. 7-Oct. 20	Oct. 30	4, 5, 7, 8, 9
Iowa	3,405	May 10-June 15	Sept.25	Oct. 10-Oct. 25	Nov. 15	Statewide
Missouri	2,732	Apr. 25-June 10	Sept. 1	Sept.10-Oct. 20	Oct. 30	Statewide
North Dakota	67	May 25-June 10	Oct. 1	Oct. 5-Oct. 20	Oct. 25	Cass, Richland, Traill
South Dakota	121	May 15-June 15	Oct. 1	Oct. 10-Oct. 20	Nov. 1	3, 6, 9
Nebraska	310	May 15-June 15	Oct. 5	Oct. 10-Oct. 25	Nov. 1	3, 6, 9
Kansas	914	May 10-July 1	Sept.15	Oct. 1-Oct. 25	Nov. 10	2, 3, 5, 6, 8, 9
Delaware	217	May 15-July 10	Oct. 5	Oct. 20-Nov. 15	Dec. 1	Statewide
Maryland	280	May 15-July 10	Oct. 5	Oct. 20-Nov. 15	Dec. 1	2, 8, 9
Virginia	389	May 1-July 10	Oct. 1	Oct. 25-Nov. 25	Dec. 5	5, 6, 9
North Carolina	558	May 10-June 25	Oct. 10	Nov. 1-Nov. 25	Dec. 15	3, 6, 9
South Carolina	640	May 1-July 15	Oct. 20	Nov. 1-Dec. 1	Dec. 5	Orangeburg, Calhoun, Darlington, Lee, Allendale, Sumter
Georgia	80	Apr. 20-June 30	Oct. 10	Oct. 25-Nov. 25	Nov. 30	Statewide
Florida	39	May 15-June 25	Oct. 15	Oct. 20-Nov. 10	Nov. 15	Calhoun, Dade, Escambia, Okaloosa, Santa Rosa
Kentucky	219	May 10-June 30	Sept.20	Oct. 1-Nov. 1	Nov. 10	1, 2
Tennessee	463	May 10-June 25	Oct. 1	Oct. 15-Nov. 20	Dec. 10	1, 2
Alabama	149	June 1-July 20	Sept.25	Oct. 10-Oct. 25	Nov. 5	Baldwin, Escambia, Mobile, Jackson, Madison
Mississippi	1,107	May 1-June 20	Sept.10	Oct. 15-Nov. 15	Dec. 15	1, 4
Arkansas	2,682	May 1-June 30	Sept.25	Oct. 15-Nov. 10	Nov. 25	Statewide
Louisiana	219	May 1-June 25	Sept.20	Oct. 1-Nov. 1	Nov. 15	3, 5
Oklahoma	171	May 10-June 10	Sept.10	Sept.15-Oct. 15	Nov. 25	3, 6, 8, 9
Texas	60	Jun 5-July 10	Oct. 20	Nov. 1-Dec. 1	Dec. 25	1n, 1s, 5n

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Sugar Beets

Sugar beets are grown in the North Central and Western areas of the United States. Most of the acreage is grown under irrigation in the Mountain and Pacific States, although considerable acreage is grown in the more humid areas of the North Central States. For successful production, the sugar beet crop requires plentiful and well-distributed moisture and extended moderately cool weather during the growing season. Acreage has increased sharply in recent years, and in 1962 growers harvested 1.1 million acres, one-sixth more than average. California is the leading State in sugar beet production followed in order by Colorado and Idaho. Most beets are seeded from March to May and harvested from September to December, with harvest reaching the peak in October. California is the only State planting some acreage in the fall for harvest the following spring.

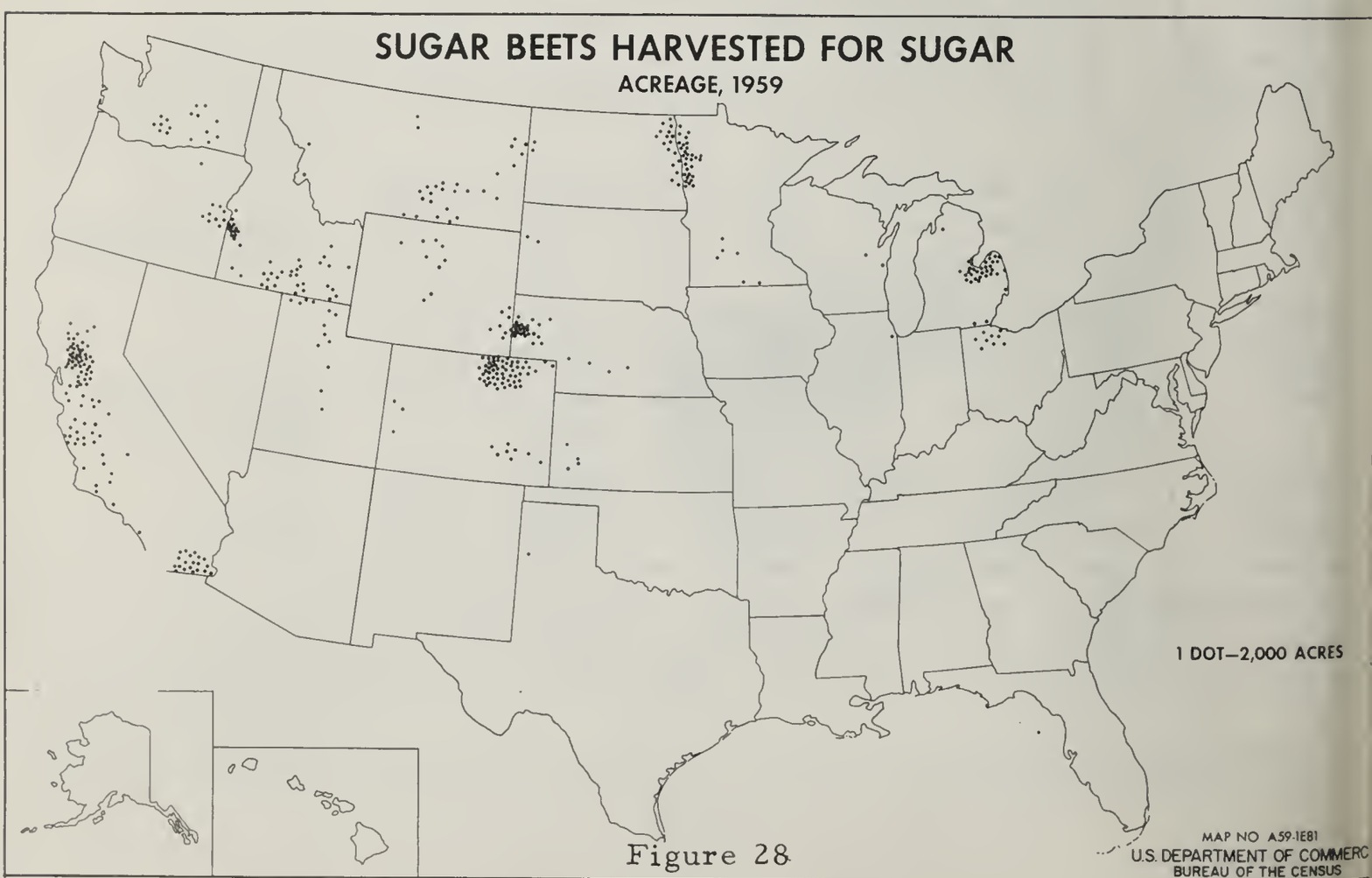


Figure 28

Table 13.--Sugar Beets: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Ohio	25.0	Apr. 10-May 15	Oct. 1	Oct. 15-Nov. 1	Nov. 10	1, 2, 4
Illinois		Mar. 30-Apr. 30	Sept. 30	Oct. 10-Oct. 30	Nov. 10	Cook
Michigan	66.2	Apr. 15-June 1	Oct. 5	Oct. 15-Nov. 1	Nov. 10	5, 6, 9
Minnesota	106.9	Apr. 25-May 30	Sept. 20	Oct. 9-Oct. 25	Nov. 1	1, 5, 8
Iowa		May 1-May 30	Sept. 15	Sept. 25-Oct. 10	Oct. 15	2, 4
North Dakota	53.9	May 15-June 15	Sept. 10	Sept. 10-Oct. 20	Oct. 25	Pembina, Walsh, Grand Forks, Cass, Traill, Richland, Williams, McKenzie
South Dakota	10.2	Apr. 20-May 15	Sept. 15	Sept. 20-Oct. 5	Oct. 15	1, 5, 9
Nebraska	72.7	Apr. 1-Apr. 30	Sept. 20	Sept. 25-Nov. 5	Nov. 10	1, 5, 7, 8
Kansas	14.0	Apr. 10-May 10	Oct. 1	Oct. 15-Nov. 1	Nov. 15	1, 4, 7
Montana	63.4	Apr. 5-May 20	Oct. 1	Oct. 5-Oct. 25	Nov. 5	Statewide
Idaho	127.1	Mar. 20-May 5	Oct. 1	Oct. 10-Nov. 10	Nov. 15	7, 8, 9
Wyoming	48.7	Apr. 5-May 20	Oct. 5	Oct. 10-Oct. 25	Oct. 30	1, 5
Colorado	170.7	Mar. 15-Apr. 30	Oct. 1	Oct. 10-Nov. 1	Nov. 15	2, 9
New Mexico		Feb. 1-Mar. 15	Nov. 1	Nov. 10-Dec. 1	Dec. 15	Curry, Torrance, Santa Fe
Utah	24.0	Mar. 20-May 20	Sept. 1	Sept. 10-Nov. 10	Nov. 20	Box Elder, Cache, Salt Lake, Weber, Sevier, Utah
Washington	55.5	Mar. 1-Mar. 31	Sept. 20	Oct. 10-Nov. 10	Nov. 20	2, 5, 9
Oregon	19.6	Mar. 10-Apr. 15	Sept. 10	Sept. 25-Oct. 15	Nov. 1	Umatilla, Malheur
California						
Fall planting	238.9	Sept. 1-Oct. 15	Apr. 1	May 10-June 30	July 15	Imperial
Spring planting 1/		Nov. 15-June 1	July 1 Mar. 1	Aug. 20-Nov. 10 Apr. 1-Apr. 20	Dec. 10 May 31	Monterey, Yolo, Solano, San Joaquin, Sacramento

1/ Some spring planted sugar beets are usually left in the ground over winter and harvested the following spring.

Tobacco

Tobacco production in the United States is generally confined to areas east of the Mississippi River--the principal exception being the Weston area of Missouri. Six major classes are grown--flue-cured, fire-cured, air-cured (light and dark), cigar filler, cigar binder, and cigar wrapper. Production is estimated for 18 States of which 6--North Carolina, Kentucky, Sou Carolina, Virginia, Tennessee, and Georgia--produce about nine-tenths of the total poundage. Although grown at various latitudes, the crop has little tolerance to frost and freezing temperatures. Tobacco seeds are usually sown during the winter and early spring in protected beds from which seedlings are pulled and transplanted in the spring. Harvesting operations are conducted mostly during summer and early fall, and completion dates are governed largely by latitude, elevation, seasonal conditions, and the nature of the particular type produced in a given belt. The flue-cured and cigar wrapper types are harvested by priming (picking the leaves as they ripen) whereas other types are for the most part stalk cut.

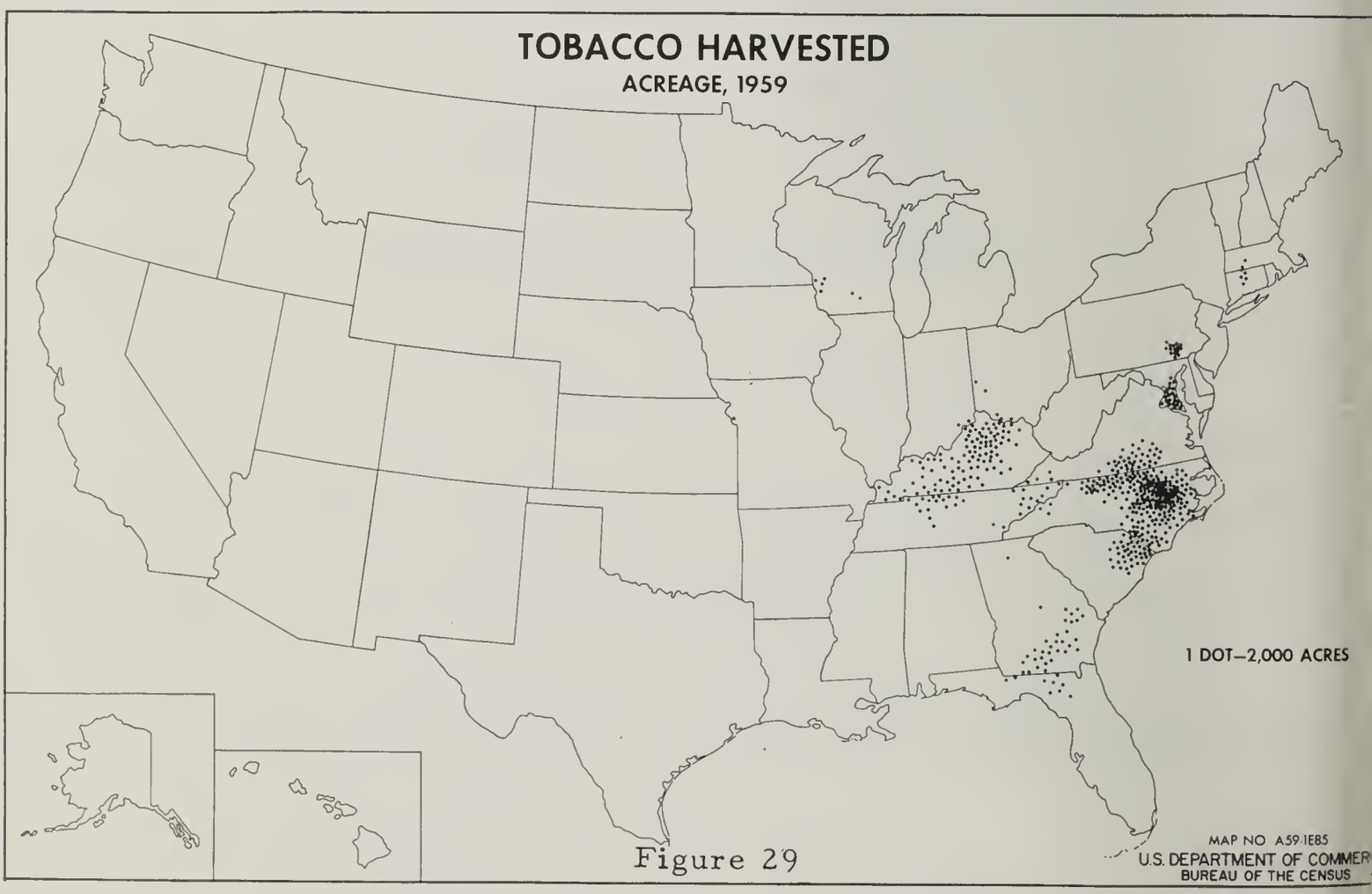


Figure 29

Table 14.--Tobacco: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Massachusetts						
Type 52	0.9	May 25-June 20	Aug. 1	Aug. 10-Aug. 25	Sept. 10	Franklin,
" 61	2.1	May 20-June 10	July 20	Aug. 1-Aug. 20	Sept. 1	Hampden & Hampshire
Connecticut						
Type 51	1.5	May 25-June 20	Aug. 1	Aug. 10-Aug. 25	Sept. 10	
" 52	.2	May 25-June 20	Aug. 1	Aug. 10-Aug. 25	Sept. 10	Hartford and
" 61	5.8	May 20-June 20	July 20	Aug. 1-Aug. 20	Sept. 1	Tolland
Pennsylvania						
Type 41	31	May 25-July 1	Aug. 10	Aug. 25-Sept. 20	Oct. 1	Lancaster, Lebanon, York, Berks, Chester
Ohio						
Type 31	10.6	May 20-June 25	Aug. 25	Sept. 5-Sept. 15	Sept. 25	8, Hamilton, Clermont
" 42-44	4.2	May 25-June 25	Aug. 25	Sept. 5-Sept. 15	Sept. 25	Darke, Miami, Montgomery, Preble, Warren
Indiana						
Type 31	7.9	May 15-June 15	Aug. 20	Sept. 1-Sept. 20	Oct. 1	8, 9, Spencer
Wisconsin						
Type 54	4.9	May 25-June 15	Aug. 20	Sept. 1-Sept. 10	Sept. 20	Dane, Rock, Columbia
" 55	7.2	June 1-June 20	Aug. 20	Sept. 1-Sept. 10	Sept. 20	Vernon, Crawford, Monroe, Richland, La Crosse
Missouri						
Type 31	3.2	May 1-May 31	Sept. 1	Sept. 5-Sept. 25	Oct. 1	Platte, Buchanan
Maryland						
Type 32	41.5	May 25-July 1	Aug. 10	Aug. 20-Sept. 10	Sept. 25	8
Virginia						
Type 11	73.5	May 5-June 5	July 15	Aug. 10-Sept. 5	Sept. 20	8, 9
" 21	7.6	May 15-June 15	Aug. 15	Aug. 25-Sept. 15	Sept. 25	5, 8
" 31	12.1	May 15-June 20	Aug. 15	Aug. 25-Sept. 20	Oct. 1	7
" 37	2.2	May 15-June 15	Aug. 15	Aug. 25-Sept. 15	Sept. 25	5
West Virginia						
Type 31	2.8	May 25-June 25	Aug. 25	Sept. 1-Sept. 25	Sept. 25	Cabell, Lincoln, Mason, Putnam
North Carolina						
Type 11	191	May 1-June 1	July 15	Aug. 1-Sept. 5	Sept. 10	2, 5
" 12	234	Apr. 15-May 15	July 5	July 15-Aug. 15	Aug. 25	3, 6
" 13	58	Apr. 10-May 10	July 1	July 10-Aug. 10	Aug. 20	9
" 31	11	May 15-June 10	Aug. 1	Aug. 10-Sept. 15	Oct. 1	1, 4
South Carolina						
Type 13	84	Apr. 10-May 10	July 1	July 5-Aug. 10	Aug. 15	3, Clarendon
Georgia						
Type 14	74	Mar. 20-Apr. 25	June 20	June 25-July 25	Aug. 1	5, 6, 7, 8, 9
" 62	1.3	Mar. 20-Apr. 25	June 20	June 25-July 25	Aug. 1	Grady, Decatur
Florida						
Type 14	14.8	Mar. 10-Apr. 10	June 1	June 10-June 25	July 15	3
" 62	4.0	Mar. 5-Mar. 25	May 25	June 1-June 25	July 1	Gadsden
Kentucky						
Type 22	6.5	May 20-June 15	Aug. 25	Sept. 5-Sept. 20	Oct. 1	2
" 23	6.6	May 20-June 15	Aug. 25	Sept. 5-Sept. 20	Oct. 1	1
" 31	224	May 20-June 30	Aug. 15	Aug. 25-Sept. 25	Oct. 10	Statewide
" 35	7.1	May 20-June 15	Aug. 25	Sept. 5-Sept. 25	Oct. 1	1, 2
" 36	4.7	May 25-June 20	Aug. 25	Sept. 5-Sept. 20	Oct. 1	2
Tennessee						
Type 22	14	May 10-June 15	Aug. 20	Aug. 25-Sept. 20	Oct. 1	Cheatham, Dickson, Montgomery, Robertson, Stewart
" 23	1.4	May 10-June 15	Aug. 20	Aug. 25-Sept. 20	Oct. 1	Henry and Weakley
" 31	67	May 10-June 15	Aug. 15	Aug. 20-Sept. 15	Oct. 1	3, 4, 5, 6
" 35	2.1	May 10-June 15	Aug. 20	Aug. 25-Sept. 20	Oct. 1	Macon, Robertson, Sumner & Weakley
Alabama						
Type 14	.5	Apr. 1-May 1	June 5	June 15-July 10	July 25	Butler, Conecuh, Covington
Louisiana						
Type 72	.35	Apr. 15-May 15	July 1	July 10-July 20	Aug. 1	St. James

Winter Wheat

Winter wheat is widely grown throughout the United States, with the heaviest concentration in the central and southern parts of the Great Plains. Five Great Plains States--Kansas, Oklahoma, Nebraska, Texas, and Colorado--harvested 60 percent of the winter wheat acreage in 1962. Among the States, Kansas led in wheat production, with 9.0 million acres harvested 27 percent of the U. S. total. Oklahoma, with 3.7 million acres harvested, and Nebraska, with 2.8 million acres, were the second and third ranking winter wheat States.

Winter wheat is planted in the fall of the year. When weather conditions are favorable for early fall growth, much of the winter wheat in the Great Plains area is grazed in the fall prior to going into dormancy and again in the late winter and early spring when new growth starts. Winter wheat harvest begins in the southernmost producing areas in the late spring and quickly spreads northward with the start of combining, usually extending well into the summer months in the northern tier of States.

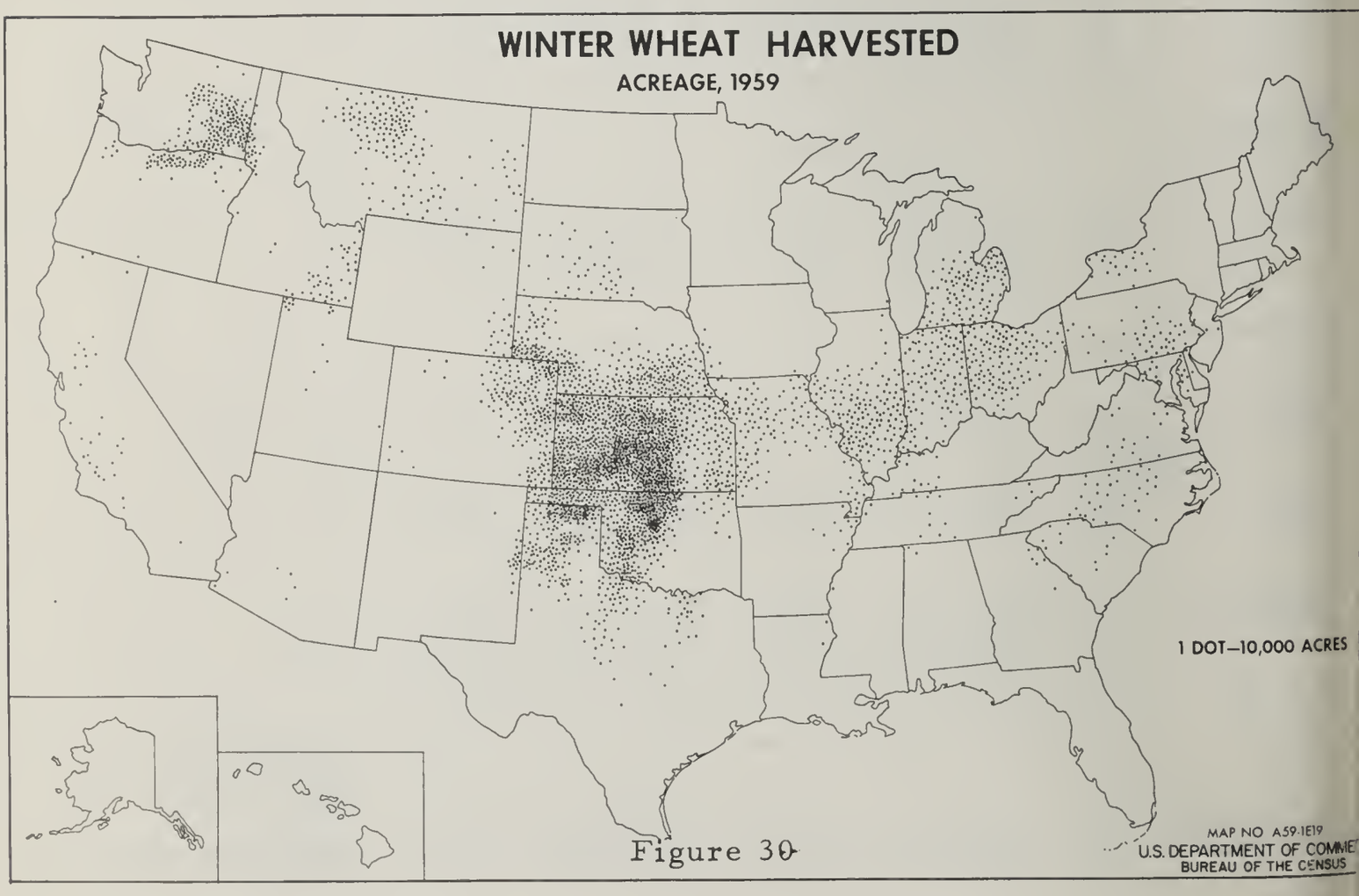


Figure 30

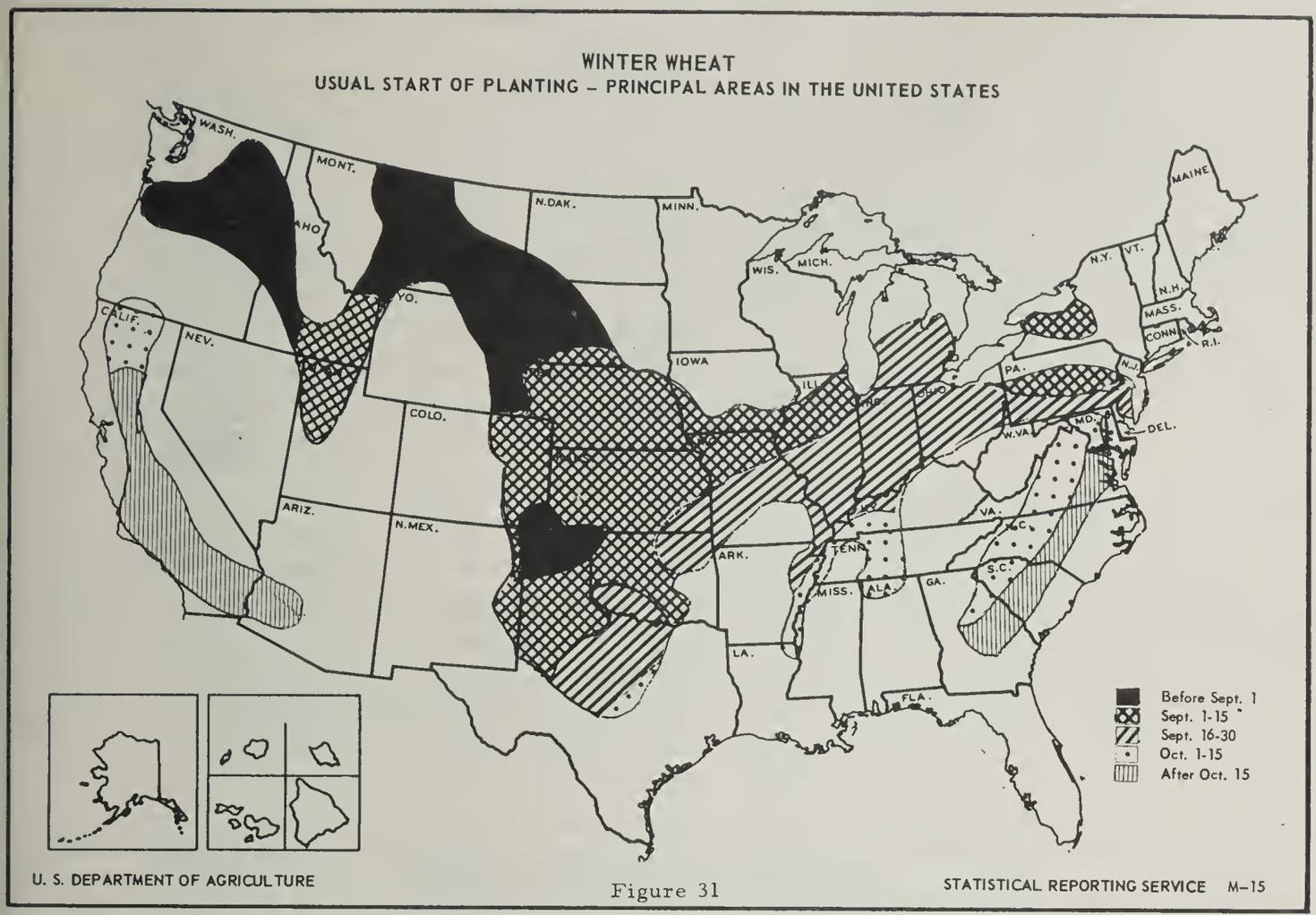


Figure 31

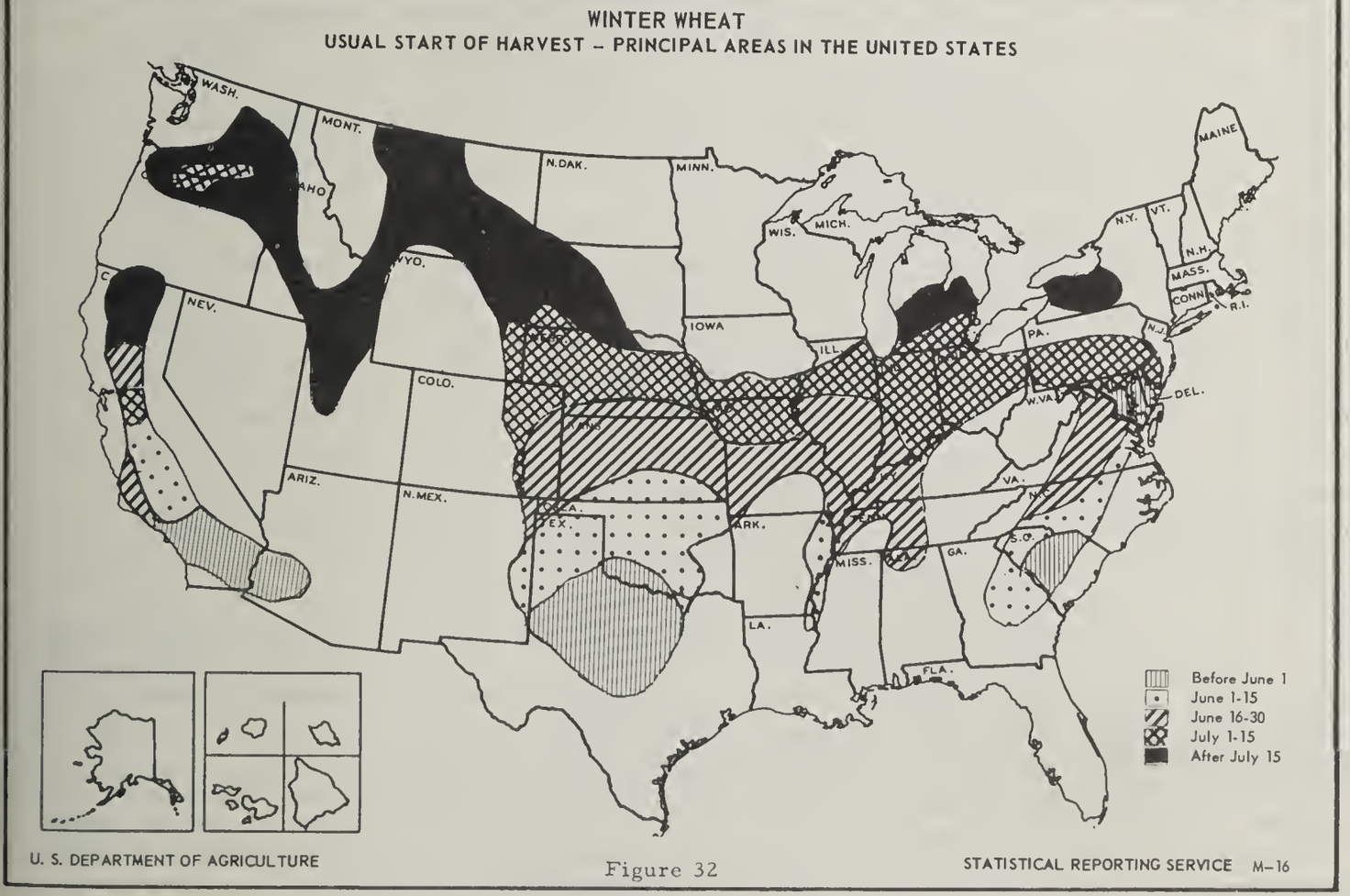


Figure 32

Table 15.--Winter Wheat: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
New York	183	Sept. 5-Oct. 10	July 15	July 25-Aug. 10	Aug. 15	4, 5
New Jersey	35	Sept.20-Oct. 20	July 5	July 15-July 25	Aug. 5	2, 5
Pennsylvania	451	Sept.15-Oct. 15	July 1	July 15-July 25	Aug. 10	4, 5, 6, 8, 9
Ohio	1,209	Sept.20-Nov. 1	July 5	July 15-July 25	Aug. 5	Statewide
Indiana	1,135	Sept.10-Oct. 25	June 20	June 30-July 25	July 30	Statewide
Illinois	1,580	Sept.15-Oct. 30	June 25	June 30-July 15	July 20	4, 4a, 5, 6, 6a, 7, 9
Michigan	922	Sept.15-Oct. 15	July 15	July 20-Aug. 1	Aug. 10	5, 6, 7, 8, 9
Wisconsin	31	Sept. 5-Oct. 1	July 10	July 20-July 30	Aug. 10	Racine, Washington, Kenosha, Ozaukee
Minnesota	21	Sept. 1-Sept 25	July 20	July 27-Aug. 8	Aug. 15	1, 4
Iowa	75	Sept.10-Oct. 20	July 5	July 10-July 25	July 30	Statewide
Missouri	976	Oct. 1-Oct. 31	June 10	June 15-July 1	July 10	Statewide
North Dakota		Sept.10-Oct. 10	July 15	Aug. 1-Aug. 20	Aug. 25	1, 4, 7
South Dakota	448	Sept. 1-Oct. 1	July 10	July 15-July 25	Aug. 5	4, 5, 7, 8
Nebraska	2,760	Sept. 1-Oct. 1	July 5	July 10-July 20	July 25	1, 5, 6, 7, 8, 9
Kansas	8,986	Sept.10-Nov. 1	June 15	June 20-July 5	July 15	Statewide
Delaware	19	Oct 5-Nov. 15	June 20	June 25-July 15	July 25	Statewide
Maryland	124	Sept.25-Nov. 15	June 20	June 25-July 15	Aug. 1	Statewide
Virginia	179	Sept.25-Dec. 1	June 10	June 20-July 10	July 15	2, 5, 6, 8
West Virginia	18	Sept.25-Oct. 20	July 10	July 15-Aug. 5	Aug. 10	6, Preston, Mason
North Carolina	204	Sept.20-Nov. 15	June 5	June 15-July 1	July 5	2, 3, 5, 6, 8, 9
South Carolina	56	Oct. 5-Dec. 20	June 5	June 15-July 1	July 5	Anderson, Orangeburg, Spartanburg, Calhoun, Laurens
Georgia	47	Oct. 1-Nov. 30	May 15	June 1-June 15	June 20	Statewide
Florida	31	Sept.15-Nov. 15	Apr. 25	May 1-May 15	May 20	1, 3
Kentucky	131	Oct. 1-Nov. 15	June 15	June 20-July 5	July 10	2, 3
Tennessee	107	Oct .10-Nov. 30	June 10	June 15-July 5	July 15	Statewide
Alabama	35	Sept.20-Dec. 5	May 20	June 1-June 20	July 5	2, Colbert, Jackson, Baldwin, Escambia
Mississippi	30	Oct. 1-Nov. 5	June 1	June 5-June 15	June 25	1, 2, 4
Arkansas	112	Sept.10-Nov. 25	June 5	June 10-June 25	July 5	Statewide
Louisiana	44	Sept.15-Oct. 30	May 20	June 1-June 15	June 20	3
Oklahoma	3,741	Sept. 1-Oct. 25	June 1	June 10-June 20	July 1	1, 2, 4, 5, 7
Texas	2,731	Sept. 1-Nov. 20	May 25	June 2-June 25	July 5	1n, 2n, 2s, 4
Montana	1,688	Aug. 25-Oct. 10	July 25	Aug. 1-Aug. 15	Sept. 1	Statewide
Idaho	608	Sept. 1-Oct. 10	July 15	July 25-Aug. 20	Aug. 30	Statewide
Wyoming	187	Aug. 20-Sept. 30	July 20	Aug. 10-Aug. 20	Sept. 5	2, 5
Colorado	1,906	Sept. 1-Oct. 15	June 20	June 25-July 15	Aug. 10	2, 6, 9
New Mexico	213	Sept. 1-Oct. 20	June 5	June 15-July 5	July 20	1, 3
Arizona	24	Nov. 15-Feb. 1	May 20	May 25-June 10	June 25	5, 7
Utah	148	Sept. 1-Sept 25	July 15	July 25-Aug. 15	Sept. 1	Box Elder, Cache, San Juan, Salt Lake, Millard, Juab
Nevada	2	Sept. 1-Oct. 20	July 10	July 20-Aug. 15	Aug. 25	Churchill, Humbolt
Washington	1,486	Aug. 15-Nov. 20	July 5	July 20-Aug. 15	Sept.20	2, 3, 5, 9
Oregon	597	Aug. 15-Feb. 1	July 1	July 10-Aug. 15	Sept.15	Statewide
California	296	Oct. 15-Feb. 15	June 15	July 15-Aug. 15	Aug. 30	5, San Luis Obispo, Monterey, Siskiyou, Modoc
		Nov. 1-Feb. 15	May 15	June 15-July 15	Aug. 8	5a, Los Angeles, Riverside

Spring Wheat

Spring wheat acreage planted in 1962 amounted to 10.4 million acres and accounted for 23 percent of the total U. S. wheat acreage. North Dakota, the leading spring wheat State, had slightly over one-half of the 10.1 million acres of spring wheat harvested in 1962. Montana was the second leading State in spring wheat acreage, with 1.8 million acres harvested; South Dakota was third, with 1.3 million acres. Durum wheat used in making macaroni and spaghetti was harvested from 2.4 million acres, representing nearly one-fourth of the total spring wheat acreage. Of the total durum acreage harvested, North Dakota had 79 percent.

Spring wheat is planted in the late spring and harvested late in the summer. In the West North Central and Northwestern States, where spring wheat is primarily grown, a high proportion of the total rainfall comes during the summer months. The favorable seasonal distribution and greater effectiveness of the precipitation make it possible to produce spring wheat with a relatively small total annual precipitation.

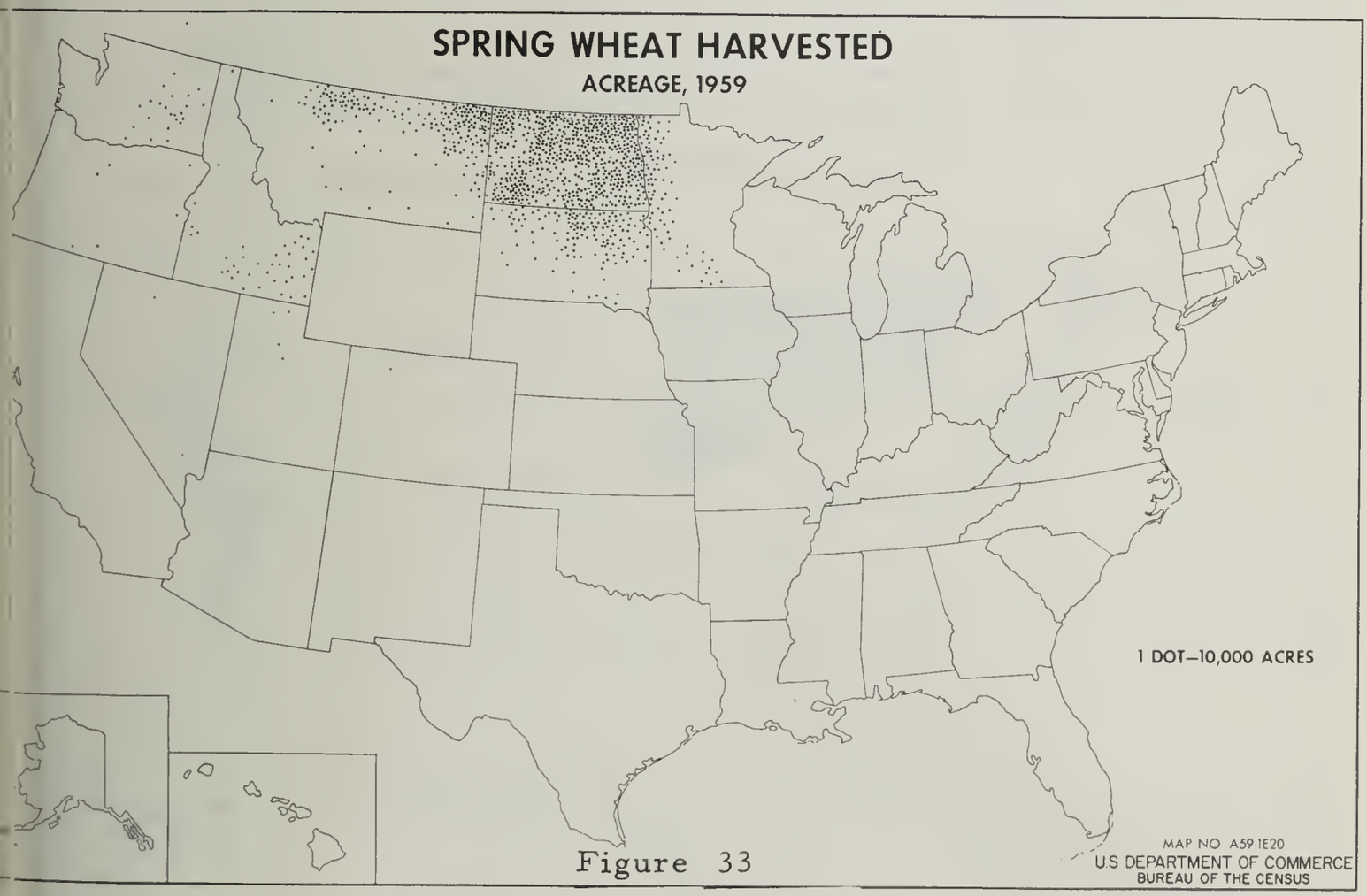


Figure 33

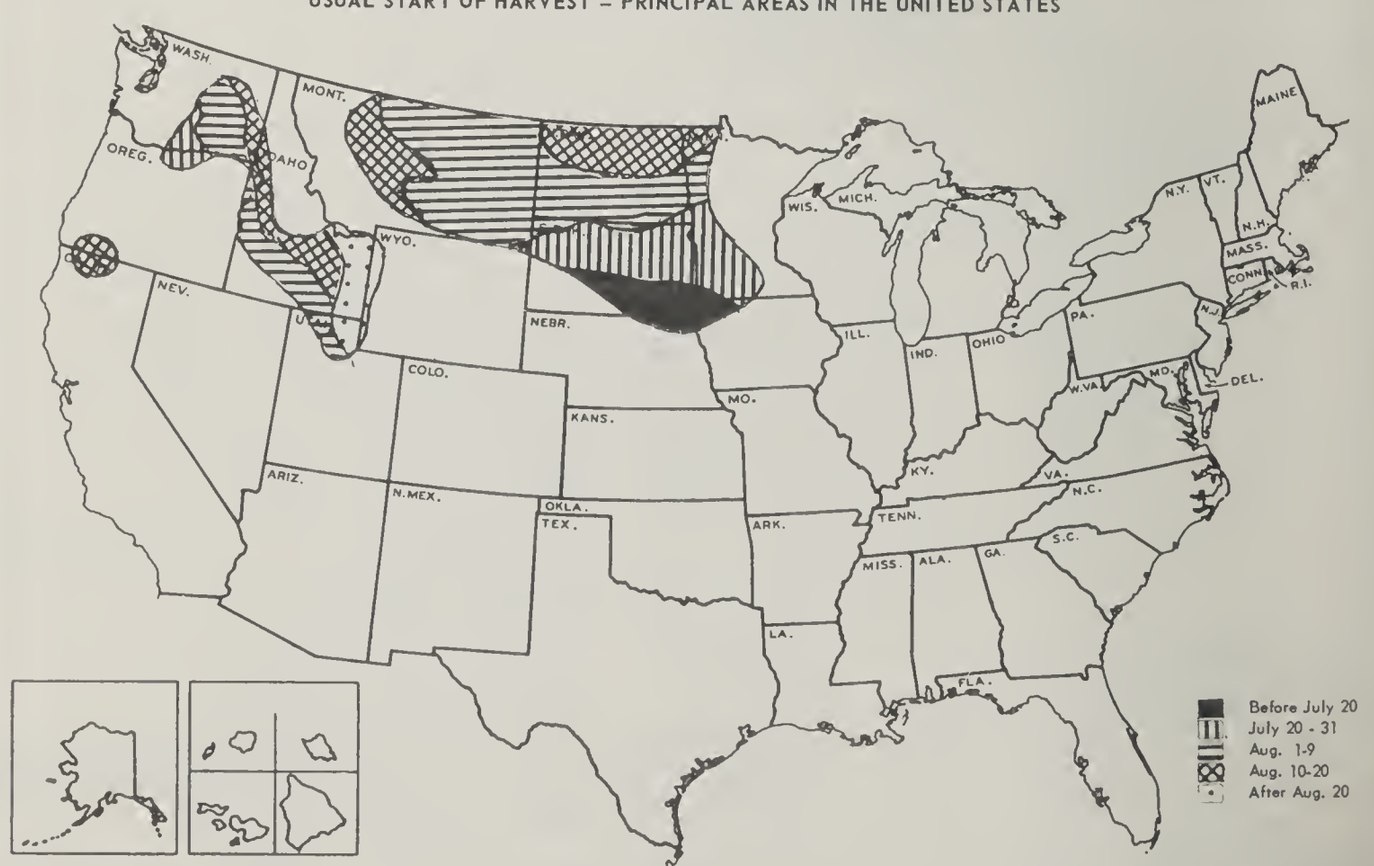
SPRING WHEAT
USUAL START OF PLANTING – PRINCIPAL AREAS IN THE UNITED STATES

U. S. DEPARTMENT OF AGRICULTURE

Figure 34

STATISTICAL REPORTING SERVICE M-17

SPRING WHEAT
USUAL START OF HARVEST – PRINCIPAL AREAS IN THE UNITED STATES



U. S. DEPARTMENT OF AGRICULTURE

Figure 35

STATISTICAL REPORTING SERVICE M-18

Table 16.--Spring Wheat: Usual planting and harvesting dates by States and principal producing areas

State	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
DURUM						
Minnesota	51	Apr. 10-May 20	July 25	Aug. 6-Aug. 18	Sept. 5	1, 4
North Dakota	1,855	Apr. 10-May 30	Aug. 1	Aug. 5-Aug. 25	Sept. 5	2, 3, 5, 6, 9
South Dakota	144	Apr. 1-May 1	July 20	July 25-Aug. 10	Aug. 15	2, 3, 5, 6
Montana	290	Apr. 10-May 20	Aug. 1	Aug. 10-Aug. 25	Sept. 20	2, 3
California	11	Mar. 15-May 10	Aug. 25	Sept. 1-Sept. 20	Sept. 30	Siskiyou, Modoc
OTHER SPRING						
Wisconsin	17	Apr. 10-May 10	July 15	July 20-July 30	Aug. 15	Sheboygan, Ozaukee, Walworth, Dane, Dodge
Minnesota	630	Apr. 10-May 20	July 25	Aug. 6-Aug. 18	Sept. 5	1, 4
Iowa	13	Apr. 1-Apr. 25	July 10	July 20-July 30	Aug. 10	Statewide
North Dakota	3,597	Apr. 10-May 20	July 25	Aug. 1-Aug. 20	Aug. 30	Statewide
South Dakota	1,129	Apr. 1-May 1	July 20	July 25-Aug. 10	Aug. 15	1, 2, 3, 5
Montana	1,487	Apr. 10-May 20	Aug. 1	Aug. 10-Aug. 25	Sept. 15	2, 3, 9
Idaho	349	Mar. 20-May 20	July 25	Aug. 10-Aug. 30	Sept. 15	Statewide
Wyoming	26	Apr. 5-May 10	Aug. 1	Aug. 10-Aug. 25	Aug. 30	1, 2, 5
Colorado	16	Mar. 10-Apr. 30	July 5	July 15-Aug. 10	Aug. 30	Statewide
Utah	41	Mar. 20-Apr. 30	Aug. 5	Aug. 10-Sept. 1	Sept. 10	Cache, Box Elder, Utah, Salt Lake
Nevada	15	Apr. 1-May 10	July 10	July 20-Aug. 5	Aug. 15	Humbolt, Pershing, Eureka
Washington	211	Mar. 10-Apr. 10	July 15	July 25-Aug. 20	Sept. 30	2, 3, 5, 9
Oregon	83	Feb. 1-Apr. 15	Aug. 15	Aug. 25-Sept. 10	Sept. 15	Statewide

Table 17.--Alabama: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Corn, Grain	1,229	Apr. 1-June 5	Aug. 25	Oct. 1-Nov. 20	Dec. 5	Statewide
Silage	15	Apr. 10-June 15	Aug. 1	Aug. 10-Sept. 10	Sept. 30	Statewide
Forage	111	Apr. 1-June 1	Aug. 1	Sept. 1-Oct. 1	Nov. 1	8,9
Cotton	900	Apr. 10-May 20	Sept. 1	Sept. 10-Oct. 25	Nov. 20	Statewide
Cowpeas for peas	9	Apr. 15-June 1	July 20	Aug. 1-Sept. 1	Sept. 15	Statewide
Hay, Alfalfa	16		May 1		Sept. 15	1,2,2a,3,4,5,6
Clo-tim	32		May 10		Oct. 1	Statewide
Lespedeza	39		Aug. 10		Oct. 15	1,2,2a,3,6
Soybean	21		Aug. 25		Sept. 25	1,2,2a,3,6
Cowpea	1		July 20		Sept. 15	2,2a,3,5,6
Peanut	72		Sept. 1		Oct. 5	8,9
Grain	65		May 1		June 20	Statewide
Other	220		May 15		Oct. 15	Statewide
Oats	83	Sept. 1-Dec. 1	May 20	June 1-June 20	July 1	Statewide
Peanuts for nuts	195	Apr. 15-May 15	Aug. 25	Sept. 15-Oct. 5	Oct. 25	9, Covington, Crenshaw
Popcorn		May 1-May 20	Sept. 1	Sept. 10-Oct. 5	Oct. 15	Jackson, DeKalb
Sorghum, Grain	10	June 1-July 15	Sept. 25	Oct. 5-Nov. 1	Nov. 25	Statewide
Silage	12	June 1-July 15	Aug. 25	Sept. 5-Sept. 20	Oct. 1	Statewide
Soybeans	149	June 1-July 20	Sept. 25	Oct. 10-Oct. 25	Nov. 5	Baldwin, Escambia, Mobile, Jackson, Madison
Tobacco, Type 14	0.5	Apr. 1-May 1	June 5	June 15-July 10	July 25	Butler, Conecuh, Covington
Velvetbeans	13	Apr. 15-June 1	Aug. 1	Aug. 20-Oct. 5	Nov. 1	6,7,8,9
Wheat, winter	35	Sept. 20-Dec. 5	May 20	June 1-June 20	July 5	2, Colbert, Jackson, Baldwin, Escambia
SEED CROPS:						
White Clover	0.7		June 10	June 15-June 25	June 25	Statewide
Lespedeza	4.5		Nov. 1	Nov. 1-Nov. 10	Nov. 10	2
Tall (Alta & Ky. 31) Fescue	4.3		June 15	June 15-June 25	June 25	2,3
Crimson Clover	11		May 25	May 25-June 5	June 5	2,5

Table 18.--Alaska: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	2.2	May 1-June 10	Sept. 5	Sept.25-Oct.10	Oct. 15	Tanana & Matanuska Valleys
Hay, Clo-tim	5.1		June 15		Oct. 15	Tanana & Matanuska Valleys
Wild	.6		Aug. 1		Oct. 1	Kenai & Southwest
Mixed grains	4.0	May 15-July 15	Aug. 15	Aug.25-Sept.20	Oct. 15	Tanana & Matanuska Valleys
Oats	1.1	Apr.25-July 5	Sept.15	Sept.25-Oct.10	Oct. 20	Tanana & Matanuska Valleys

Table 19.--Arizona: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley, Fall sown	120	Oct. 1-Dec. 31	May 20	May 25-June 10	June 20	5
Spring sown		Jan.20-Feb. 28	June 10	June 15-June 30	July 5	9
Corn, Grain	15	Apr.15-June 1	Aug. 15	Oct. 1-Oct. 25	Nov. 10	2, 9
Silage	8	Mar.15-Apr.10	June 20	July 1-July 20	Aug. 1	5
Forage	5	Mar.15-Apr.10	June 20	July 1-July 20	Aug. 1	5
Cotton	405	Mar.15-Apr.25	Sept. 15	Oct.25-Dec. 5	Jan.15	5, 7, 9
Hay, alfalfa	210		Mar. 15		Dec. 1	5, 7
Oats, Fall sown	7	Oct. 1-Nov. 20	May 5	May 25-June 15	June 20	5
Spring sown		Mar.15-Apr. 30	Aug. 1	Aug.20-Sept. 5	Sept.15	2
Safflower		Dec. 1-Feb. 1	July 5	July 15-Aug.10	Aug. 20	5
Sorghum, Grain						
Early	98	May 1-July 1	July 5	July 20-Aug. 5	Aug. 10	5, 7, 9
Late			Oct. 1	Oct. 20-Nov.25	Dec. 15	5, 7, 9
Silage						
Early	22	Mar.15-Aug. 1	June 25	July 5-July 20	July 25	5
Late			Sept.15	Sept.25-Oct.20	Nov. 1	5
Wheat, winter	24	Nov.15-Feb. 1	May 20	May 25-June 10	June 25	5, 7
SEED CROPS:						
Alfalfa	20		July 25	July 30-Sept.15	Oct. 15	5, 7

Table 20.--Arkansas: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	28	Sept. 1-Nov. 20	June 1	June 10-June 25	July 5	Statewide
Corn, Grain	207	Apr. 10-May 25	Sept. 15	Oct. 1-Nov. 20	Dec. 10	Statewide
Silage	6	Apr. 10-May 25	Aug. 20	Aug. 25-Sept.15	Sept.20	Statewide
Forage	8	Apr. 10-May 25	Aug. 20	Aug. 25-Sept.15	Sept.20	Statewide
Cotton	1,355	Apr. 25-May 25	Sept. 10	Oct. 1-Oct. 10	Dec. 15	Statewide
Cowpeas for peas	4	Apr. 20-June 25	Aug. 25	Sept. 5-Oct. 5	Oct. 15	Statewide
Hay, Alfalfa	42		May 15		Sept.15	Statewide
Clo-tim	92		June 1		Aug. 1	Statewide
Lespedeza	208		July 25		Oct. 1	Statewide
Wild	113		Aug. 1		Sept.25	Statewide
Oats, Fall sown	106	Sept.15-Nov. 15	June 1	June 5-June 20	June 30	Statewide
Spring sown		Feb. 15-Mar. 15	June 10	June 15-July 1	July 5	Statewide
Rice	426	Apr. 20-May 25	Sept. 20	Oct. 1-Oct. 20	Nov. 1	3, 6, 9
Sorghum, Grain	12	May 1-June 15	Oct. 10	Oct. 15-Nov. 1	Nov. 5	Statewide
Silage	17	May 1-June 15	Aug. 20	Sept. 1-Sept.20	Oct. 1	Statewide
Soybeans	2,682	May 1-June 30	Sept. 25	Oct. 15-Nov. 10	Nov. 25	Statewide
Wheat, winter	112	Sept.10-Nov. 25	June 5	June 10-June 25	July 5	Statewide
SEED CROPS						
Lespedeza	16		Nov. 10	Nov. 15-Dec. 1	Dec. 5	3, 6
Tall (Alta & Ky. 31) Fescue	5		June 20	June 25-July 1	July 5	1, 3, 7
Crimson clover	2		June 1	June 5-June 15	June 20	Independence, Arkansas, Clark, Desha
Hairy vetch	4		June 20	June 25-July 1	July 5	3, 5, 6, 9

Table 21.--California: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley, Fall sown	1,461	Oct. 15-Apr. 15	May 15	June 1-July 15	Aug. 15	4, 5, 5a, 8
Spring sown		Mar. 1-May 1	Aug. 15	Sept. 1-Sept. 20	Sept. 30	Modoc, Siskiyou
Beans, dry	230	Apr. 15-July 10	Aug. 20	Sept. 15-Oct. 30	Nov. 15	5, 5a, 8, Monterey
Corn, Grain	77	May 1-July 1	Sept. 15	Oct. 1-Nov. 10	Nov. 30	5a, Sacramento, Solano, Butte
Silage	57	Apr. 1-Aug. 1	Aug. 1	Sept. 1-Oct. 15	Oct. 30	5a, Sacramento, Solano, Butte
Cotton	809	Apr. 1-May 1	Oct. 1	Oct. 15-Dec. 1	Jan. 15	Fresno, Kings, Kern, Tulare, Imperial
Flaxseed	32	Nov. 1-Jan. 15	May 15	June 15-July 5	July 20	Imperial
		Nov. 15-May 1	Aug. 15	Sept. 1-Sept. 15	Sept. 30	San Mateo
Hay, Alfalfa	1,156		Apr. 15		Nov. 5	5a, Imperial
Wild	103		June 1		Aug. 31	Northern counties
Grain	420		May 15		July 31	4, 5, 5a, 8
Other	202		June 1		Sept. 30	4, 5, 5a, 8
Oats, Fall sown	153	Nov. 1-Mar. 1	July 1	July 15-July 30	Aug. 15	Sonoma, Butte, Sutter, Solano, Sacramento
Spring sown		Mar. 15-May 10	Aug. 25	Sept. 1-Sept. 20	Sept. 30	Modoc, Siskiyou
Rice	323	Apr. 1-June 1	Sept. 15	Oct. 10-Oct. 30	Nov. 30	5, Fresno
Safflower		Feb. 15-June 1	July 1	Aug. 1-Aug. 20	Sept.15	5
		Dec. 15-Feb. 15	July 10	July 15-Aug. 15	Aug. 20	Fresno, Tulare, Kings
Sorghum, Grain	206	May 1-Aug. 1	Sept. 15	Oct. 1-Nov. 10	Nov. 25	5, 5a, Imperial
Silage	19	Mar. 1-July 1	July 1	Aug. 1-Sept. 30	Oct. 30	5, 5a, Imperial
Sugar Beets, Fall planting	238.9	Sept. 1-Oct. 15	Apr. 1	May 10-June 30	July 15	Imperial
Spring planting 1/		Nov. 15-June 1	July 1	Aug. 20-Nov. 10	Dec. 10	Monterey, Yolo, Solano, San Joaquin, Sacramento
			Mar. 1	Apr. 1-Apr. 30	May 31	
Wheat, Winter	296	Oct. 15-Feb. 15	June 15	July 15-Aug. 15	Aug. 30	5, San Luis Obispo, Monterey, Siskiyou, Modoc
		Nov. 1-Feb. 15	May 15	June 15-July 15	Aug. 8	5a, Los Angeles, Riverside
Durum	11	Mar. 15-May 10	Aug. 25	Sept. 1-Sept. 20	Sept. 30	Siskiyou, Modoc
SEED CROPS:						
Alfalfa	115		Aug. 15	Sept. 1-Sept. 30	Oct. 15	Fresno, Kern, Kings, Stanislaus, Imperial
Red Clover	1.2		Sept. 1	Sept. 15-Oct. 15	Oct. 31	Stanislaus, Merced
Ladino Clover	18.5		Aug. 20	Sept. 1-Sept. 20	Oct. 10	Glenn, Tehama, Sacramento
Merion Kentucky Bluegrass	.59		July 1	July 5-July 25	July 31	Kern
Sudangrass	16		Aug. 15	Sept. 1-Sept. 20	Sept. 30	Yolo, Colusa, Sacramento
Common Vetch	.6		July 1	July 5-July 25	July 31	Butte, Sutter
Purple Vetch	30		June 25	July 5-July 25	July 31	Butte, Sutter
Mustard			July 1	July 5-July 25	July 31	Santa Barbara

1/ Some spring planted sugar beets are usually left in the ground over winter and harvested the following spring.

Table 22.--Colorado: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley, Fall sown	431	Sept. 1-Oct. 15	June 20	July 1-July 20	Aug. 5	2, 6, 9
Spring sown		Mar. 15-Apr. 30	June 30	July 5-Aug. 15	Aug. 15	1, 2, 6, 7, 8
Beans, dry	234	May 10-June 5	Aug. 25	Sept. 1-Sept. 30	Oct. 10	2, 6, 7, 9
Broomcorn	56	May 15-June 30	Sept. 1	Sept. 15-Oct. 15	Oct. 30	Baca
Corn, Grain	198	Apr. 20-May 20	Sept. 25	Oct. 15-Nov. 10	Nov. 20	2, 6, 7, 9
Silage	180	Apr. 20-May 20	Aug. 25	Aug. 30-Sept. 15	Sept. 25	2, 6, 7, 9
Forage	21	Apr. 20-May 20	Sept. 1	Sept. 5-Sept. 20	Oct. 1	2, 6
Hay, Alfalfa	845		June 10		Sept. 25	Statewide
Clo-tim	222		July 10		Aug. 25	1
Wild	282		Aug. 1		Sept. 20	1, 8
Oats	101	Mar. 15-Apr. 25	July 1	July 10-Aug. 15	Aug. 30	Statewide
Peas, dry	7	Apr. 10-May 10	Aug. 1	Aug. 10-Aug. 20	Sept. 1	8
Rye	48	Aug. 25-Oct. 15	July 1	July 10-July 30	Aug. 15	2, 6, 9
Sorghum, Grain	278	May 10-June 15	Sept. 15	Oct. 1-Nov. 1	Nov. 10	6, 9
Silage	32	May 10-June 5	Sept. 1	Sept. 5-Sept. 20	Sept. 30	6, 9
Sugar Beets	170.7	Mar. 15-Apr. 30	Oct. 1	Oct. 10-Nov. 1	Nov. 15	2, 9
Wheat, Winter	1,906	Sept. 1-Oct. 15	June 20	June 25-July 15	Aug. 10	2, 6, 9
Spring	16	Mar. 10-Apr. 30	July 5	July 15-Aug. 10	Aug. 30	Statewide
SEED CROPS:						
Alfalfa	16		Aug. 1	Aug. 25-Sept. 30	Oct. 15	2, 7, 9
Sweetclover	3		Aug. 1	Aug. 25-Sept. 30	Oct. 15	2, 6, 7, 8, 9
Sudangrass	35		Aug. 15	Aug. 25-Sept. 25	Oct. 10	3, 6, 9

Table 23.--Delaware: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	14	Sept. 25-Nov. 10	June 10	June 20-July 5	July 10	Statewide
Corn, Grain	119	May 1-June 15	Sept. 15	Sept. 20-Oct. 20	Nov. 15	Statewide
Silage	5	May 5-June 25	Aug. 25	Sept. 5-Sept. 20	Oct. 5	Statewide
Hay, Alfalfa	6		May 25		Sept. 25	Statewide
Clo-tim	20		June 1		Sept. 1	Statewide
Lespedeza	9		Aug. 25		Sept. 20	Statewide
Oats	6	Sept. 20-Nov. 10	June 15	June 25-July 10	July 20	Statewide
Rye	10	Sept. 25-Nov. 15	June 20	June 25-July 15	July 20	Statewide
Soybeans	217	May 15-July 10	Oct. 5	Oct. 20-Nov. 15	Dec. 1	Statewide
Wheat, winter	19	Oct. 5-Nov. 15	June 20	June 25-July 15	July 25	Statewide

Table 24.--Florida: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Corn, Grain	315	Mar. 5-Apr. 15	Aug. 15	Sept. 1-Sept. 30	Oct. 15	1, 3, 5
Silage	10	Mar. 5-Apr. 15	July 15	July 20-Aug. 5	Aug. 15	1, 3, 5
Forage	121	Mar. 5-Apr. 15	July 25	Sept. 1-Oct. 31	Nov. 30	1, 3, 5
Cotton	20.6	Apr. 1-Apr. 30	Aug. 15	Aug. 25-Oct. 1	Oct. 15	1, 3
Hay, peanut	18		Aug. 25	Sept. 1-Oct. 15	Nov. 1	Statewide
Oats	15	Sept. 15-Nov. 1	Apr. 20	May 1-May 10	May 30	1, 3, 5
Peanuts for nuts	48	Apr. 1-Apr. 30	Aug. 20	Sept. 1-Oct. 15	Oct. 25	Jackson, Santa Rosa, Holmes Calhoun, Levy, Marion
Soybeans	39	May 15-June 25	Oct. 15	Oct. 20-Nov. 10	Nov. 15	Calhoun, Dade, Escambia, Okaloosa, Santa Rosa
Sugarcane for sugar	114.3	Feb. 1-May 31	Nov. 1	Dec. 15-Mar. 15	May 1	Lake Okeechobee area
Tobacco, Type 14	14.8	Mar. 10-Apr. 10	June 1	June 10-June 25	July 15	3
Type 62	4.0	Mar. 5-Mar. 25	May 25	June 1-June 25	July 1	Gadsden
Velvetbeans	13	Mar. 5-Apr. 15	July 25	Sept. 1-Oct. 31	Nov. 30	Columbia, Marion, Suwannee
Wheat, winter	31	Sept. 15-Nov. 15	Apr. 25	May 1-May 15	May 20	1, 3
SEED CROPS:						
Lupine	3		Apr. 25	May 1-May 15	May 20	Alachua, Columbia, Gilchrist, Jefferson, Lafayette, Levy, Madison, Suwannee

Table 25.--Georgia: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	12	Oct. 1-Dec. 1	May 20	May 25-June 5	June 15	1,2,3,4,5,6
Corn,						
Grain	1,692	Mar. 20-May 25	Sept. 1	Sept. 15-Nov. 1	Dec. 1	Statewide
Silage	48	Apr. 10-May 25	July 15	Aug. 1-Aug. 25	Sept. 1	Statewide
Forage	326	Mar. 20-May 25	July 15	Aug. 15-Oct. 1	Oct. 15	4, 5, 6, 7, 8, 9
Cotton	692	Apr. 1-May 10	Aug. 20	Sept. 1-Oct. 1	Nov. 15	Statewide
Cowpeas for peas	22	Apr. 15-May 30	July 15	Aug. 5-Sept. 5	Oct. 1	Statewide
Hay,						
Alfalfa	16		May 1		Sept. 15	1, 2, 3, 4, 5
Lespedeza	50		June 1		Sept. 30	Statewide
Oats,						
Fall sown	139	Oct. 1-Dec. 1	May 10	May 25-June 10	June 20	Statewide
Spring sown		Jan. 15-Mar. 1	May 25	June 5-June 20	July 1	Statewide
Peanuts for nuts	472	Apr. 10-May 20	Aug. 15	Aug. 15-Sept. 15	Oct. 15	4, 5, 6, 7, 8
Rye	24	Sept. 15-Nov. 15	May 15	June 1-June 15	July 1	Statewide
Sorghum,						
Grain	10	May 1-July 1	Oct. 15	Oct. 25-Nov. 10	Dec. 1	Statewide
Silage	18	May 1-July 1	July 5	July 20-Aug. 20	Sept. 1	Statewide
Soybeans	80	Apr. 20-June 30	Oct. 10	Oct. 25-Nov. 25	Nov. 30	Statewide
Tobacco,						
Type 14	74	Mar. 20-Apr. 25	June 20	June 25-July 25	Aug. 1	5, 6, 7, 8, 9
Type 62	1.3	Mar. 20-Apr. 25	June 20	June 25-July 25	Aug. 1	Grady, Decatur
Velvetbeans	55	Apr. 1-May 1	Oct. 15	Oct. 25-Nov. 5	Nov. 15	4, 5, 6, 7, 8, 9
Wheat, winter	47	Oct. 1-Nov. 30	May 15	June 1-June 15	June 20	Statewide
SEED CROPS:						
Lespedeza	11		Oct. 10	Oct. 20-Nov. 10	Nov. 30	Statewide
Tall (Alta & Ky. 31) Fescue	4.5		June 10	June 15-June 30	July 10	Statewide
Crimson Clover	12		May 1	May 10-May 20	May 30	Statewide
Lupine	2		May 10	May 20-June 1	June 15	6, 7, 8

Table 26.--Hawaii: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Sugarcane for sugar	1,086	Jan. 1-Dec. 31	Jan. 1	Mar. 1-Oct. 31	Dec. 1	Hawaii, Kauai , Maui, Oahu Islands

Table 27.--Idaho: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley,						
Fall sown	648	Sept. 1-Oct. 10	July 15	July 25-Aug. 15	Aug. 25	1, 9
Spring sown		Mar. 25-May 25	July 25	Aug. 5-Sept. 20	Sept. 30	Statewide
Beans, dry	125	May 20-June 10	Aug. 20	Aug. 25-Sept. 5	Sept. 15	7, 8
Corn,						
Grain	23	May 1-May 25	Oct. 10	Oct. 20-Nov. 15	Dec. 10	7, 8
Silage	55	May 1-June 5	Sept. 1	Sept. 10-Sept. 30	Oct. 15	7, 8, 9
Forage	1	May 1-June 5	Oct. 1	Oct. 10-Oct. 30	Nov. 5	7, 8
Hay,						
Alfalfa	959		June 5		Oct. 15	Statewide
Clo-tim	118		June 20		Sept. 1	Statewide
Wild	103		July 10		Aug. 15	Statewide
Grain	29		July 25		Aug. 10	Statewide
Other	21		June 10		Aug. 15	Statewide
Lentils		Apr. 15-May 5	Aug. 5	Aug. 15-Aug. 25	Sept. 5	1
Oats	141	Mar. 25-May 25	Aug. 1	Aug. 10-Sept. 20	Oct. 10	Statewide
Peas, dry	131	Apr. 10-May 10	July 25	Aug. 1-Aug. 20	Aug. 30	1, 8, 9
Rye	8	Sept.15-Sept.30	July 10	July 20-July 30	Aug. 5	Statewide
Sugar Beets	127.1	Mar. 20-May 5	Oct. 1	Oct. 10-Nov. 10	Nov. 15	7, 8, 9
Wheat,						
Winter	608	Sept. 1-Oct. 10	July 15	July 25-Aug. 20	Aug. 30	Statewide
Spring	349	Mar. 20-May 20	July 25	Aug. 10-Aug. 30	Sept. 15	Statewide
SEED CROPS:						
Alfalfa	52		Sept. 10	Sept. 20-Oct. 15	Oct. 20	7, 8
Red Clover	12		Sept. 10	Sept. 20-Oct. 15	Oct. 20	7, 8
Alsike Clover	1.2		Aug. 10	Aug. 15-Oct. 25	Sept. 1	1, 7
White Clover (Including Ladino)	10.5		Aug. 10	Aug. 20-Sept. 10	Sept. 15	1
Merion Kentucky Bluegrass	2.1		July 10	July 15-July 25	Aug. 1	1
Red Fescue	.2		July 10	July 20-Aug. 1	Aug. 5	1
Tall (Alta & Ky. 31) Fescue	.9		July 20	July 25-Aug. 1	Aug. 5	1
Crested Wheatgrass	6		Aug. 10	Aug. 20-Sept. 1	Sept. 5	8
Austrian Winter Peas	39		Aug. 1	Aug. 10-Sept. 5	Sept. 15	1
Rapeseed			July 15	July 20-Aug. 5	Aug. 10	Lewis, Nez Perce

Table 28.--Illinois: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley, Fall sown	52	Aug. 20-Sept.20	June 20	June 25-July 5	July 15	4a, 6a, 7, 9
Spring sown		Apr. 5-Apr. 30	July 15	July 20-July 30	Aug. 5	1, 3
Broomcorn	.7	May 10-June 20	Aug. 20	Aug. 30-Sept.30	Oct. 15	6a
Corn, Grain	8,270	May 5-June 20	Oct. 5	Oct. 20-Nov. 15	Dec. 5	Statewide
Silage	284	May 5-June 10	Sept.5	Sep. 5-Sept.15	Sept.25	1, 3
Forage	52	May 5-June 20	Sept.5	Sep. 10-Sept.25	Oct. 1	Statewide
Cotton	2	Apr. 20-May 15	Sept.15	Sept.30-Oct. 25	Nov. 5	Alexander, Pulaski
Hay, Alfalfa	1,070		May 30		Sept.5	Statewide
Clo-tim	855		May 30		July 15	Statewide
Lespedeza	34		Aug. 15		Sept.15	7, 9
Soybean	11		Aug. 5		Aug. 30	Statewide
Oats	1,503	Mar. 25-Apr. 30	July 5	July 15-July 30	Aug. 5	1, 3, 4, 5, 6
Popcorn	24	May 5-June 20	Oct. 10	Oct. 20-Nov. 20	Dec. 5	Gallatin
Rye	55	Aug. 20-Sep 20	June 20	June 25-July 5	July 5	Statewide
Sorghum, Grain	6	May 10-June 20	Oct. 10	Oct. 20-Nov. 20	Dec. 10	4a, 6a, 7
Silage	2	May 10-June 15	Sept.10	Sept.10-Sept.20	Sept.30	Statewide
Soybeans	5,575	May 10-June 30	Sept.15	Sept.25-Oct. 10	Oct. 30	Statewide
Sugar Beets		Mar. 30-Apr. 30	Sept.30	Oct. 10-Oct. 30	Nov. 10	Cook
Wheat, winter	1,580	Sept.15-Oct. 30	June 25	June 30-July 15	July 20	4, 4a, 5, 6, 6a, 7, 9
SEED CROPS:						
Red Clover	172		Aug. 25	Sept. 5-Sept.15	Sept.25	4a, 6a, 7, 9
Sweetclover	5		Aug. 5	Aug. 10-Aug. 20	Aug. 25	4a, 6a, 7, 9
Lespedeza	23		Oct. 30	Nov. 5-Nov. 15	Nov. 20	Lawrence
Timothy	11		July 30	Aug. 5-Aug. 15	Aug. 20	Statewide
Redtop	9		July 20	July 25-Aug. 5	Aug. 10	6a, 9

Table 29.--Indiana: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley, Fall sown	42	Sept. 1-Sept.30	June 10	June 15-June 25	July 1	4, 5, 6, 7, 8, 9
Spring sown		Apr. 1-Apr. 20	July 1	July 10-July 20	July 30	1, 2, 3, 4, 5, 6
Corn, Grain	4,298	May 5-June 5	Oct. 5	Oct. 15-Nov. 15	Nov. 30	Statewide
Silage	134	May 5-June 5	Sept. 5	Sept.10-Sept.20	Sept.30	Statewide
Forage	39	May 5-June 5	Sept.25	Oct. 1-Oct. 20	Oct. 30	Statewide
Hay, Alfalfa	563		May 25		Sept.10	Statewide
Clo-tim	629		June 10		Aug. 15	Statewide
Lespedeza	58		Sept. 1		Sept.20	7, 8, 9
Other	56		June 25		Oct. 1	Statewide
Oats, Fall sown	605	Sept. 1-Sept.30	June 20	June 25-July 5	July 10	7, 8, 9
Spring sown		Apr. 1-Apr. 25	July 1	July 10-July 30	Aug. 5	Statewide
Popcorn	38	May 10-June 5	Oct. 10	Oct. 20-Nov. 10	Nov. 25	Statewide
Rye	53	Sept.10-Oct. 15	June 15	June 20-July 15	July 20	Statewide
Sorghum, Grain	11	May 5-June 5	Sept.25	Sept.30-Oct. 10	Oct. 15	Statewide
Silage	4	May 5-June 5	Sept. 5	Sept.10-Sept.20	Sept.30	Statewide
Soybeans	2,708	May 10-June 20	Sept.10	Sept.20-Oct. 20	Oct. 30	Statewide
Tobacco, Type 31	7.9	May 15-June 15	Aug. 20	Sept. 1-Sept.20	Oct. 1	8, 9, Spencer
Wheat, winter	1,135	Sept.10-Oct. 25	June 20	June 30-July 25	July 30	Statewide
SEED CROPS:						
Red Clover	100		Aug. 1	Aug. 30-Sept.30	Oct. 15	Statewide
Lespedeza	30		Oct. 15	Oct. 25-Nov. 10	Nov. 15	7, 8, 9
Timothy	8		July 15	July 30-Aug. 10	Aug. 15	Statewide

Table 30.--Iowa: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	11	Apr. 1-Apr. 25	July 15	July 20-July 30	Aug. 10	Statewide
Corn, Grain	9,776	May 5-June 5	Oct. 5	Oct. 25-Nov. 20	Dec. 10	Statewide
Silage	274	May 5-June 5	Aug. 25	Sept. 5-Sept.20	Sept. 30	Statewide
Forage	81	May 5-June 5	Aug. 20	Aug. 30-Sept.15	Sept. 20	Statewide
Flaxseed	10	Apr. 10-May 10	July 15	July 25-Aug. 10	Aug. 20	1, 2
Hay, Alfalfa	2,232		May 30		Sept. 10	Statewide
Clo-tim	1,231		June 10		Sept. 10	Statewide
Oats	2,947	Apr. 1-May 1	July 10	July 20-July 30	Aug. 10	Statewide
Popcorn	34	May 1-May 25	Oct. 5	Oct. 15-Oct. 30	Nov. 15	1, 2, 4, 5, 7
Rye	5	Aug. 25-Sept.20	June 25	July 5-July 15	July 20	Statewide
Soybeans	3,405	May 10-June 15	Sept. 25	Oct. 10-Oct. 25	Nov. 15	Statewide
Sorghum, Grain	12	May 10-June 10	Oct. 5	Oct. 20-Nov. 5	Nov. 15	Statewide
Silage	9	May 10-June 15	Aug. 25	Sept. 5-Sept.25	Oct. 5	Statewide
Sugar Beets		May 1-May 30	Sept. 15	Sept.25-Oct. 10	Oct. 15	2, 4
Wheat, Winter	75	Sept.10-Oct. 20	July 5	July 10-July 25	July 30	Statewide
Spring	13	Apr. 1-Apr. 25	July 10	July 20-July 30	Aug. 10	Statewide
SEED CROPS:						
Red Clover	72		Aug. 25	Sept. 5-Sept.20	Oct. 1	Statewide
Timothy	22		July 20	July 30-Aug. 10	Aug. 15	Statewide
Kentucky bluegrass			June 10	June 15-June 25	June 30	7, 8
Smooth bromegrass	1.5		July 15	July 25-Aug. 10	Aug. 25	4, 7

Table 31.--Kansas: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley,						
Fall sown	689	Sept. 10-Nov. 1	June 10	June 15-July 1	July 5	Statewide
Spring sown		Feb. 25-June 1	June 25	June 25-July 10	July 15	Statewide
Beans, dry	17	May 25-July 1	Aug. 20	Sept. 1-Sept. 20	Oct. 1	4, 7
Broomcorn	2.3	May 10-June 20	Aug. 15	Sept. 10-Oct. 20	Nov. 1	7
Corn,						
Grain	1,298	Apr. 15-June 10	Sept. 15	Oct. 5-Nov. 10	Dec. 5	Statewide
Silage	201	Apr. 20-June 20	Aug. 20	Aug. 25-Oct. 1	Oct. 10	Statewide
Forage	13	Apr. 20-June 20	Sept. 20	Oct. 1-Oct. 20	Nov. 1	Statewide
Hay,						
Alfalfa	1,201		May 15		Oct. 15	Statewide
Clo-tim	104		June 1		Aug. 25	3, 6, 9
Lespedeza	38		Aug. 10		Sept. 15	3, 6, 9
Wild	701		July 15		Sept. 1	Statewide
Oats	351	Feb. 15-May 1	June 20	June 25-July 10	July 20	Statewide
Popcorn	4.3	May 20-June 20	Oct. 10	Oct. 10-Nov. 1	Nov. 10	2, 3, 6
Rye	189	Sept. 1-Oct. 1	June 5	June 10-June 25	July 1	Statewide
Sorghum,						
Grain	2,960	May 10-July 1	Sept. 25	Oct. 10-Nov. 10	Dec. 1	Statewide
Silage	506	May 10-July 1	Sept. 1	Sept. 10-Oct. 10	Oct. 15	Statewide
Soybeans	914	May 10-July 1	Sept. 15	Oct. 1-Oct. 25	Nov. 10	2, 3, 5, 6, 8, 9
Sugar Beets	14	Apr. 10-May 10	Oct. 1	Oct. 15-Nov. 1	Nov. 15	1, 4, 7
Wheat, winter	8,986	Sept. 10-Nov. 1	June 15	June 20-July 5	July 15	Statewide
SEED CROPS:						
Alfalfa	94		Aug. 15	Sept. 1-Oct. 1	Oct. 15	Statewide
Red Clover	30		Aug. 1	Aug. 20-Sept. 20	Oct. 1	3, 6, 9
Sweetclover	16		July 5	July 15-Aug. 10	Aug. 20	2, 3, 5, 6, 8, 9
Lespedeza	10		Oct. 15	Oct. 25-Nov. 20	Dec. 1	3, 6, 9
Smooth Bromegrass	10		July 1	July 10-Aug. 1	Aug. 10	2, 3, 5, 6, 9
Sudangrass	4.4		Aug. 15	Aug. 25-Sept. 25	Oct. 10	Statewide

Table 32.--Kentucky: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	53	Aug. 20-Sept. 30	June 5	June 15-July 1	July 10	2, 3
Corn,						
Grain	1,116	Apr. 25-June 20	Sept. 25	Oct. 5-Nov. 5	Nov. 20	Statewide
Silage	70	May 5-June 25	Aug. 15	Aug. 20-Sept. 10	Sept. 20	3, 4, 5
Forage	11	May 1-June 25	Aug. 10	Aug. 20-Sept. 10	Sept. 20	1, 3, 4, 6
Cotton	6.5	Apr. 20-May 20	Sept. 15	Oct. 1-Oct. 25	Dec. 1	Fulton, Hickman
Hay,						
Alfalfa	330		May 15		Sept. 15	2, 3, 4, 5
Clo-tim	466		June 5		Aug. 15	2, 3, 5, 6
Lespedeza	564		Aug. 10		Oct. 10	1, 2, 3, 5
Soybean	52		Aug. 15		Sept. 10	2, 3, 6
Grain	60		May 25		July 10	3, 5, 6
Other	147		June 15		July 15	3, 5
Oats,						
Fall sown	43	Aug. 25-Sept. 30	June 15	June 20-July 5	July 15	1, 2, 3
Spring sown		Mar. 1-Apr. 15	June 25	July 1-July 15	July 25	3, 5, 6
Popcorn	21	Apr. 25-June 10	Sept. 20	Oct. 1-Oct. 25	Nov. 10	Calloway, Graves, Todd, Logan, Christian, Union
Rye	10	Sept. 10-Oct. 15	June 15	June 25-July 10	July 15	2, 5
Sorghum,						
Grain	10	May 1-June 10	Oct. 1	Oct. 15-Nov. 1	Nov. 10	2, 3
Silage	5	May 5-June 20	Aug. 15	Aug. 20-Sept. 10	Sept. 20	3, 4
Soybeans	219	May 10-June 30	Sept. 20	Oct. 1-Nov. 1	Nov. 10	1, 2
Tobacco,						
Type 22	6.5	May 20-June 15	Aug. 25	Sept. 5-Sept. 20	Oct. 1	2
Type 23	6.6	May 20-June 15	Aug. 25	Sept. 5-Sept. 20	Oct. 1	1
Type 31	224	May 20-June 30	Aug. 15	Aug. 25-Sept. 25	Oct. 10	Statewide
Type 35	7.1	May 20-June 15	Aug. 25	Sept. 5-Sept. 25	Oct. 1	1, 2
Type 36	4.7	May 25-June 20	Aug. 25	Sept. 5-Sept. 20	Oct. 1	2
Wheat,						
winter	131	Oct. 1-Nov. 15	June 15	June 20-July 5	July 10	2, 3
SEED CROPS:						
Red Clover	14		July 25	Aug. 10-Sept. 15	Sept. 30	2, 3
Lespedeza	50		Oct. 1	Oct. 25-Nov. 20	Nov. 30	Simpson, Logan, Christian
Orchardgrass	22		June 15	June 20-June 30	June 30	Oldham, Shelby, Henry
Kentucky Bluegrass			June 1	June 5-June 15	June 20	Bourbon, Scott, Woodford, Fayette, Harrison Clark
Tall (Alta & Ky. 31) Fescue	53		June 15	June 20-June 30	July 10	1, 2, 3

Table 33.--Louisiana: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Corn, Grain	222	Mar. 1-Apr. 30	Aug. 1	Sept. 1-Oct. 1	Oct. 15	Statewide
Silage	15	Mar. 1-Apr. 30	July 15	July 20-Aug. 15	Aug. 20	1,5,6
Forage	25	Mar. 1-Apr. 30	Aug. 1	Sept. 1-Oct. 1	Oct. 15	Statewide
Cotton	565	Apr. 10-May 10	Aug. 25	Sept. 15-Nov. 15	Dec. 1	1,2,3,5
Cowpeas for peas	4	Mar. 15-Apr. 30	July 1	Aug. 1-Sept. 1	Sept. 30	1,2
Hay, Alfalfa	16		Apr. 1		Oct. 15	1
Lespedeza	43		Aug. 1		Oct. 15	3,5,6,7
Soybean	7		Aug. 15		Sept. 30	1,3,5
Grain	31		Apr. 10		May 10	1,3,5,6
Oats	38	Sept. 15-Oct. 30	May 10	May 20-June 10	June 15	1,3,5,6,7
Rice	508	Apr. 10-May 31	Aug. 10	Sept. 1-Oct. 1	Oct. 15	3,5,7,8
Sorghum, Grain	4	May 15-June 30	Aug. 15	Sept. 1-Oct. 1	Oct. 15	3,7
Silage	3	May 15-June 30	July 15	Aug. 1-Sept. 1	Sept. 15	1,5,6
Soybeans	219	May 1-June 25	Sept. 20	Oct. 1-Nov. 1	Nov. 15	3,5
Sugarcane for sugar	253.7	Aug. 15-Oct. 1	Oct. 15	Nov. 1-Dec. 1	Jan. 1	5,8,9
Tobacco, Type 72	.35	Apr. 15-May 15	July 1	July 10-July 20	Aug. 1	St. James
Wheat, winter	44	Sept. 15-Oct. 30	May 20	June 1-June 15	June 20	3
SEED CROPS:						
White Clover	10		May 15	May 30-June 30	July 15	5,7

Table 34.--Maryland: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	91	Sept. 25-Nov. 10	June 10	June 20-July 5	July 10	Statewide
Corn,						
Grain	354	May 1-June 15	Sept. 15	Oct. 1-Nov. 1	Nov. 20	Statewide
Silage	99	May 5-June 25	Aug. 25	Sept. 1-Sept. 20	Oct. 5	Statewide
Hay,						
Alfalfa	92		May 20		Sept. 25	Statewide
Clo-tim	212		June 1		Sept. 1	Statewide
Lespedeza	36		Aug. 25		Sept. 20	Statewide
Oats,						
Fall sown	50	Sept. 20-Nov. 10	June 15	June 25-July 10	July 25	Statewide
Spring sown		Mar. 20-May 1	June 25	July 5-July 25	Aug. 5	Statewide
Popcorn		May 1-June 15	Sept. 15	Sept. 25-Oct. 10	Nov. 1	Carroll, Frederick, Washington, Cecil, Kent
Rye	18	Sept. 25-Nov. 15	June 20	June 25-July 15	July 25	Statewide
Soybeans	280	May 15-July 10	Oct. 5	Oct. 20-Nov. 15	Dec. 1	2, 8, 9
Tobacco, type 32	41	May 25-July 1	Aug. 10	Aug. 20-Sept. 10	Sept. 25	8
Wheat, winter	124	Sept. 25-Nov. 15	June 20	June 25-July 15	Aug. 1	Statewide
SEED CROPS:						
Red Clover	6		Aug. 20	Aug. 25-Sept. 10	Sept. 25	2, 9
Lespedeza	10		Sept. 25	Oct. 1-Nov. 1	Nov. 15	Queen Annes, St. Marys, Caroline, Dorchester, Talbot

Table 35.--Michigan: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley,						
Fall sown	62	Sept. 5-Sept. 15	June 25	July 1-July 10	Aug. 1	5, 8, 9
Spring sown		Sept.10-May 10	July 15	July 20-Aug. 1	Aug. 5	6, 7
Beans, dry	573	May 25-June 20	Sept. 1	Sept.10-Oct. 1	Oct. 15	5, 6, 8, 9
Corn,						
Grain	1,408	May 5-June 10	Oct. 10	Oct. 20-Nov. 10	Dec. 1	5, 6, 7, 8, 9
Silage	349	May 5-June 10	Sept. 1	Sept.15-Oct. 10	Oct. 25	5, 6, 7, 8, 9
Forage	22	May 5-June 10	Sept. 5	Sept.15-Oct. 10	Oct. 25	5, 6, 7, 8, 9
Hay,						
Alfalfa	1,235		June 10		Sept. 1	Statewide
Clo-tim	466		June 15		July 10	Statewide
Oats	754	Apr. 10-May 15	July 20	July 25-Aug. 20	Aug. 25	Statewide
Popcorn	5.8	May 15-June 1	Oct. 10	Oct. 20-Nov. 5	Nov. 25	7, 8, 9
Rye	42	Aug. 15-Oct. 15	July 15	July 20-Aug. 1	Aug. 10	Statewide
Soybeans	351	May 20-June 20	Sept. 25	Oct. 5-Oct. 25	Nov. 1	5, 6, 7, 8, 9
Sugar Beets	66.2	Apr. 15-June 1	Oct. 5	Oct. 15-Nov. 1	Nov. 10	5, 6, 9
Wheat, Winter	922	Sept.15-Oct. 15	July 15	July 20-Aug. 1	Aug. 10	5, 6, 7, 8, 9
SEED CROPS:						
Alfalfa	8		Aug. 10	Sept.15-Oct. 10	Nov. 1	3, 5, 6, 9
Red Clover	74		Aug. 5	Sept. 1-Sept. 25	Oct. 20	5, 6, 7, 8, 9
Sweetclover	3		July 15	July 25-Aug. 15	Oct. 1	6, 9

Table 36.--Minnesota: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	719	Apr. 15-May 20	July 20	Aug. 1-Aug. 18	Sept. 5	1, 4
Beans, dry		May 18-June 1	Aug. 20	Sept. 2-Sept. 6	Sept. 20	1
Corn, Grain	4,575	May 10-June 5	Oct. 5	Oct. 21-Nov. 9	Nov. 30	4, 5, 6, 7, 8, 9
Silage	865	May 10-June 5	Sept. 15	Sept.20-Sept.30	Oct. 10	Statewide
Forage	48	May 10-June 5	Oct. 5	Oct. 10-Nov. 10	Nov. 30	Statewide
Flaxseed	510	Apr. 20-June 5	Aug. 10	Aug. 18-Sept.15	Oct. 10	1, 4, 7
Hay, Alfalfa	2,457		June 20		Aug. 30	Statewide
Clo-tim	532		June 20		Aug. 30	Statewide
Wild	399		July 10		Aug. 30	Statewide
Oats	3,026	Apr. 15-May 20	July 20	Aug. 2-Aug. 16	Aug. 30	Statewide
Peas, dry	3	Apr. 20-June 1	Aug. 10	Aug. 21-Aug. 28	Sept. 10	1
Rye	86	Sept. 1-Sept.25	July 20	July 27-Aug. 8	Aug. 15	1, 4, 5, 6
Soybeans	2,201	May 15-June 10	Sept. 20	Oct. 7-Oct. 20	Oct. 30	4, 5, 7, 8, 9
Sugar beets	106.9	Apr. 25-May 30	Sept. 20	Oct. 9-Oct. 25	Nov. 1	1, 5, 8
Wheat, Winter	21	Sept. 1-Sept.25	July 20	July 27-Aug. 8	Aug. 15	1, 4
Durum	51	Apr. 10-May 20	July 25	Aug. 6-Aug. 18	Sept. 5	1, 4
Other spring	630	Apr. 10-May 20	July 25	Aug. 6-Aug. 18	Sept. 5	1, 4
SEED CROPS:						
Alfalfa	3.5		Sept. 5	Sept.20-Oct. 1	Oct. 25	1, 2, 4
Red clover	27		Sept. 5	Sept.15-Oct. 5	Oct. 15	1, 2, 4, 5, 6, 9
Alsike clover	1.8		Aug. 1	Aug. 10-Sept. 2	Oct. 1	1, 2
Sweetclover	14		Aug. 5	Aug. 10-Sept. 5	Oct. 10	1, 2, 4
Timothy	27		Aug. 1	Aug. 7-Aug. 20	Aug. 30	1, 2
Kentucky bluegrass			July 1	July 3-July 7	July 15	1, 4

Table 37.--Mississippi: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Corn, Grain	764	Apr. 1-May 31	Sept. 1	Oct. 15-Nov. 15	Dec. 15	Statewide
Silage	17	May 1-June 30	July 20	Aug. 15-Sept.15	Sept. 25	Statewide
Forage	28	May 1-June 10	Aug. 1	Sept. 1-Oct. 1	Nov. 1	Statewide
Cotton	1,585	Apr. 10-May 20	Sept. 5	Sept.20-Oct. 20	Nov. 30	1, 2, 4
Cowpeas for peas	10	Apr. 20-June 20	July 25	Aug. 15-Sept.15	Sept. 30	2, 5, 6
Hay, Alfalfa	9		May 15		Sept. 30	1, 3, 4, 6
Clo-tim	58		May 20		July 31	5, 7, 8
Lespedeza	130		Aug. 1		Oct. 15	2, 3
Oats, Fall sown	132	Sept.25-Nov. 5	May 20	June 1-June 10	June 20	1, 4
Spring sown		Feb. 15-Mar. 15	June 1	June 10-June 20	June 30	Statewide
Peanuts for nuts	5	Apr. 15-May 25	Aug. 20	Sept. 5-Sept.20	Oct. 10	5, 6, 7, 9
Rice	49	Apr. 15-May 31	Sept. 10	Oct. 1-Oct. 15	Nov. 15	1, 4
Sorghum, Grain	6	May 1-June 30	Sept. 15	Oct. 15-Nov. 15	Nov. 30	1, 4
Silage	15	May 1-June 30	July 15	Aug. 15-Sept.15	Sept. 20	2, 3, 6
Soybeans	1,107	May 1-June 20	Sept. 10	Oct. 15-Nov. 15	Dec. 15	1, 4
Wheat, winter	30	Oct. 1-Nov. 5	June 1	June 5-June 15	June 25	1, 2, 4
SEED CROPS:						
White clover	0.6		June 15	June 20-June 30	July 10	6, 7, 8, 9
Lespedeza	4		Oct. 25	Nov. 1-Nov. 15	Nov. 25	2, 3, 6
Tall (Alta & Ky. 31) Fescue	1.5		June 15	June 20-June 30	July 20	Statewide
Crimson clover	3.5		May 20	May 25-May 31	June 10	6, 7, 8, 9

Table 38.--Missouri: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	101	Sept. 10-Oct. 1	June 1	June 5-June 15	June 20	6, 7, 8, 9
Corn,						
Grain	2,982	Apr. 25-May 31	Sept. 15	Oct. 1-Nov. 10	Nov. 30	Statewide
Silage	229	Apr. 25-May 31	Sept. 1	Sept.10-Sept. 25	Sept. 30	Statewide
Forage	33	Apr. 25-May 31	Sept. 1	Sept.10-Sept. 25	Sept. 30	Statewide
Cotton	383	Apr. 20-May 20	Sept. 15	Oct. 1-Nov. 15	Dec. 1	9
Hay,						
Alfalfa	651		June 15		Sept. 15	Statewide
Clo-tim	1,396		June 1		Aug. 20	Statewide
Lespedeza	313		July 15		Sept. 20	Statewide
Wild	173		Aug. 1		Aug. 31	4, 5, 7
Oats,						
Fall sown	316	Sept. 1-Sept.30	June 5	June 10-June 20	June 25	7, 8, 9
Spring sown		Mar. 1-Apr. 15	June 15	June 20-July 10	July 15	Statewide
Popcorn	9	May 1-May 31	Sept. 1	Sept.25-Nov. 1	Nov. 30	1, 2, 4, 9
Rice	4.6	May 1-May 20	Oct. 1	Oct. 5-Oct. 25	Oct. 30	Marion, St. Charles, Lincoln, Lewis, Scott, Stoddard, Pemiscot, Butler, New Madrid, Dunklin, Ripley
Rye	30	Aug. 15-Sept. 30	June 1	June 10-June 25	June 30	Statewide
Sorghum,						
Grain	177	May 15-June 15	Sept. 15	Sept.25-Oct. 20	Oct. 30	Statewide
Silage	44	May 15-June 15	Aug. 15	Aug. 25-Sept. 25	Oct. 1	Statewide
Soybeans	2,732	Apr. 25-June 10	Sept. 1	Sept. 10-Oct. 20	Oct. 30	Statewide
Tobacco,						
Type 31	3.2	May 1-May 31	Sept. 1	Sept. 5-Sept. 25	Oct. 1	Platte, Buchanan
Wheat, Winter	976	Oct. 1-Oct. 31	June 10	June 15-July 1	July 10	Statewide
SEED CROPS:						
Red Clover	127		July 20	Aug. 5-Sept. 15	Sept. 30	Statewide
Sweetclover	2.5		July 20	July 20-Aug. 10	Aug. 15	Statewide
Lespedeza	56		Nov. 1	Nov. 5-Nov. 20	Nov. 30	Statewide
Timothy	58		July 5	July 10-Aug. 1	Aug. 5	1, 2, 3, 5, 6, 7
Orchardgrass	16		June 1	June 10-June 25	July 1	Statewide
Redtop	30		July 5	July 10-Aug. 1	Aug. 5	2, 3, 5, 6, 7
Kentucky Bluegrass			June 5	June 10-June 20	June 20	1, 4
Tall (Alta & Ky. 31)Fescue	26		June 5	June 10-June 25	July 1	Statewide
Smooth Bromegrass	3.9		July 1	July 10-July 25	Aug. 1	Statewide
Hairy Vetch			June 1	June 10-June 20	June 30	9

Table 39.--Montana: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	1,802	Apr. 1-May 30	July 25	Aug. 5-Aug. 25	Sept. 10	Statewide
Beans, dry	12	May 10-June 10	Aug. 25	Sept. 10-Oct. 1	Oct. 5	3, 8, 9
Corn, Grain	4	May 10-June 10	Sept. 15	Sept. 20-Oct. 5	Oct. 15	Statewide
Silage	48	May 10-June 10	Sept. 1	Sept. 5-Sept. 20	Sept. 25	Statewide
Forage	28	May 10-June 10	Sept. 5	Sept. 10-Sept. 25	Oct. 1	3, 9
Flaxseed	23	Apr. 20-June 10	Aug. 25	Sept. 5-Sept. 20	Oct. 5	2, 3
Hay, Alfalfa	1,017		June 10		Sept. 20	Statewide
Clo-tim	270		June 25		Sept. 15	Statewide
Wild	666		July 5		Sept. 15	Statewide
Oats	263	Apr. 5-June 1	Aug. 1	Aug. 10-Sept. 1	Sept. 15	Statewide
Rye	37	Aug. 20-Oct. 10	July 20	July 25-Aug. 15	Sept. 1	2, 3
Safflower		Apr. 20-May 15	Sept. 5	Sept. 15-Oct. 1	Oct. 15	3
Sugar Beets	63.4	Apr. 5-May 20	Oct. 1	Oct. 5-Oct. 25	Nov. 5	Statewide
Wheat, winter	1,688	Aug. 25-Oct. 10	July 25	Aug. 1-Aug. 15	Sept. 1	Statewide
Durum	290	Apr. 10-May 20	Aug. 1	Aug. 10-Aug. 25	Sept. 20	2, 3
Other spring	1,487	Apr. 10-May 20	Aug. 1	Aug. 10-Aug. 25	Sept. 15	2, 3, 9
SEED CROPS:						
Alfalfa	13		Sept. 5	Sept. 15-Oct. 5	Oct. 15	Statewide
Red Clover	.9		Sept. 1	Sept. 10-Oct. 1	Oct. 10	1, 8
Crested Wheatgrass	17		Aug. 1	Aug. 10-Aug. 25	Sept. 1	2, 3, 5, 8, 9
Mustard			Aug. 25	Sept. 5-Sept. 25	Oct. 10	1, 2, 3, 5

Table 40.--Nebraska: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates: Begins	Most active	Ends	Principal producing areas and counties
Barley,						
Fall sown	135	Sept. 10-Oct. 10	June 25	July 10-July 20	Aug. 20	1, 7
Spring sown		Apr. 5-May 1	June 25	July 10-July 20	Aug. 20	1, 7
Beans, dry	81	May 20-June 5	Aug. 25	Sept. 1-Sept. 15	Sept. 20	1
Castor Beans		May 1-June 1	Oct. 25	Nov. 1-Nov. 25	Dec. 1	7, 8
Corn, Grain	5,031	May 5-June 10	Oct. 15	Nov. 1-Nov. 20	Dec. 5	3, 5, 6, 9
Silage	208	May 5-June 10	Aug. 10	Aug. 25-Sept. 5	Sept. 15	1, 3, 5, 6, 7
Forage	56	May 5-June 10	Sept. 1	Sept. 15-Oct. 1	Oct. 5	3, 5, 7
Flaxseed		Apr. 15-Apr. 25	Aug. 15	Aug. 20-Sept. 20	Oct. 1	1
Hay, Alfalfa	1,831		June 5		Sept. 30	1, 2, 3, 5, 6, 9
Clo-tim	75		June 20		Aug. 15	3, 6, 9
Wild	3,062		July 15		Sept. 30	1, 2
Oats	971	Apr. 5-May 1	July 10	July 15-Aug. 1	Aug. 15	3, 6, 9
Rye	225	Aug. 15-Sept. 20	June 25	July 1-Aug. 10	Aug. 15	1, 2, 3, 7
Safflower		Apr. 20-May 20	Sept. 5	Sept. 15-Oct. 15	Nov. 1	1, 7
Sorghum,						
Grain	1,540	May 15-June 15	Oct. 10	Oct. 20-Nov. 5	Nov. 20	5, 6, 7, 8, 9
Silage	111	May 15-June 15	Aug. 10	Aug. 25-Sept. 5	Sept. 15	5, 6, 7, 8, 9
Soybeans	310	May 15-June 15	Oct. 5	Oct. 10-Oct. 25	Nov. 1	3, 6, 9
Sugar beets	72.7	Apr. 1-Apr. 30	Sept. 20	Sept. 25-Nov. 5	Nov. 10	1, 5, 7, 8
Wheat, winter	2,760	Sept. 1-Oct. 1	July 5	July 10-July 20	July 25	1, 5, 6, 7, 8, 9
SEED CROPS:						
Alfalfa	63		Sept. 5	Sept. 15-Oct. 5	Oct. 10	1, 2, 3, 5, 9
Red Clover	28		Aug. 25	Sept. 1-Sept. 20	Sept. 25	3, 6, 9
Sweetclover	13		July 20	July 25-Aug. 15	Aug. 20	3, 6, 9
Smooth Bromegrass	7		July 5	July 10-Aug. 1	Aug. 5	3, 6, 9
Crested Wheatgrass	3		July 25	Aug. 1-Aug. 20	Aug. 25	1
Hairy Vetch	22		July 5	July 10-Aug. 1	Aug. 5	Central Northeast

Table 41.--Nevada: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley,						
Fall sown	13	Sept. 1-Oct. 20	June 15	July 1-Aug. 15	Sept. 1	Pershing, Churchill
Spring sown		Apr. 20-May 10	July 20	July 25-Aug. 15	Sept. 1	Lyon, Douglas, Clark
Corn, Silage	5	Apr. 15-May 15	Sept. 20	Oct. 1-Oct. 25	Nov. 1	Churchill, Clark, Humboldt, Pershing
Cotton	3.5	Apr. 1-Apr. 20	Oct. 1	Oct. 25-Dec. 15	Jan. 1	Nye
Hay, Alfalfa	122		May 15		Oct. 1	Churchill, Lyon, Pershing, Douglas, Elko
Clo-tim	48		June 1		Sept. 1	Elko, Washoe, Douglas, Humboldt
Wild	160		July 15		Aug. 15	Elko, Humboldt, Nye, Washoe
Oats	3	Apr. 20-May 10	July 20	July 25-Aug. 20	Sept. 1	Douglas, Humboldt, Lyon, Nye
Wheat, Winter	2	Sept. 1-Oct. 20	July 10	July 20-Aug. 15	Aug. 25	Churchill, Humboldt
Spring	15	Apr. 1-May 10	July 10	July 20-Aug. 5	Aug. 15	Humboldt, Pershing, Eureka
SEED CROPS:						
Alfalfa	5.5		Aug. 15	Aug. 25-Oct. 5	Oct. 15	Humboldt

Table 42.--New Jersey: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley,						
Fall sown	21	Sept. 15-Sept. 30	June 15	June 20-July 10	July 15	5, 8
Spring sown		Mar. 25-Apr. 20	June 15	June 20-July 10	July 15	5, 8
Corn, Grain	78	May 15-June 15	Oct. 5	Oct. 20-Nov. 5	Nov. 25	Statewide
Silage	43	May 15-June 25	Sept. 5	Sept. 15-Sept. 30	Oct. 25	Statewide
Forage	2	May 15-July 1	Sept. 1	Sept. 15-Sept. 25	Oct. 20	2
Hay, Alfalfa	89		May 25		Sept. 20	Statewide
Clo-tim	70		June 5		Sept. 20	Statewide
Oats,						
Fall sown	18	Sept. 20-Oct. 10	July 15	July 20-Aug. 10	Aug. 20	5, 8
Spring sown		Mar. 15-Apr. 25	July 15	July 20-Aug. 10	Aug. 20	2
Rye	10	Sept. 1-Oct. 15	July 5	July 15-July 25	Aug. 5	2, 5, 8
Soybeans	42	May 25-July 10	Oct. 20	Oct. 25-Nov. 10	Nov. 20	5, 8
Wheat, winter	35	Sept. 20-Oct. 20	July 5	July 15-July 25	Aug. 5	2, 5

Table 43.--Maine: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Corn, Silage	11	May 20-June 20	Sept. 5	Sept. 15-Oct. 1	Oct. 10	Statewide
Hay, Alfalfa	9		June 15		Sept. 10	Statewide
Clo-tim	334		June 20		Aug. 20	Statewide
Oats	49	May 10-June 10	Aug. 25	Sept. 5-Sept. 20	Oct. 1	Aroostook, Penobscot

Table 44.--New Hampshire: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Corn, Silage	10	May 20-June 20	Sept. 5	Sept. 15-Oct. 1	Oct. 10	Statewide
Hay, Alfalfa	13		June 15		Sept. 10	Statewide
Clo-tim	107		June 20		Aug. 20	Statewide

Table 45.--Vermont: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Corn, Grain	1	May 20-June 20	Oct. 1	Oct. 15-Oct. 25	Nov. 1	Statewide
Silage	41	May 20-June 20	Sept. 5	Sept. 15-Oct. 1	Oct. 10	Statewide
Hay, Alfalfa	116		June 15		Sept. 10	Statewide
Clo-tim	383		June 20		Aug. 20	Statewide
Oats	14	Apr. 25-June 5	Aug. 1	Aug. 10-Aug. 25	Sept. 1	Statewide

Table 46.--Massachusetts: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates: Begins	Most active	Ends	Principal producing areas and counties
Corn, Grain	2	May 15-June 20	Oct. 1	Oct. 15-Oct. 25	Nov. 1	Statewide
Silage	25	May 15-June 20	Sept. 5	Sept. 15-Oct. 1	Oct. 10	Statewide
Hay, Alfalfa	34		June 5		Sept. 15	Statewide
Clo-tim	131		June 10		Aug. 15	Statewide
Tobacco, Type 52	.9	May 25-June 20	Aug. 1	Aug. 10-Aug. 25	Sept. 10	Franklin, Hampden, Hampshire
Type 61	2.1	May 20-June 10	July 20	Aug. 1-Aug. 20	Sept. 1	Franklin, Hampden, Hampshire

Table47.--Rhode Island: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates: Begins	Most active	Ends	Principal producing areas and counties
Corn, Silage	5	May 15-June 20	Sept. 5	Sept. 15-Oct. 1	Oct. 10	Statewide
Hay, Alfalfa	5		June 5		Sept. 15	Statewide
Clo-tim	11		June 10		Aug. 15	Statewide

Table 48.--Connecticut: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates: Begins	Most active	Ends	Principal producing areas and counties
Corn, Grain	2	May 15-June 20	Oct. 1	Oct. 15-Oct. 25	Nov. 1	Statewide
Silage	33	May 15-June 20	Sept. 5	Sept. 15-Oct. 1	Oct. 10	Statewide
Hay, Alfalfa	40		June 5		Sept. 15	Statewide
Clo-tim	90		June 10		Aug. 15	Statewide
Tobacco, Type 51	1.5	May 25-June 20	Aug. 1	Aug. 10-Aug. 25	Sept. 10	Hartford, Tolland
Type 52	.23	May 25-June 20	Aug. 1	Aug. 10-Aug. 25	Sept. 10	Hartford, Tolland
Type 61	5.8	May 20-June 10	July 20	Aug. 1-Aug. 20	Sept. 1	Hartford, Tolland

Table 49.--New Mexico: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley,						
Fall sown	37	Sept. 1-Nov. 1	June 10	June 15-July 10	July 20	1, 3, 7, 9
Spring sown		Feb. 15-Apr. 1	June 20	June 25-July 15	Aug. 1	1, 3, 7, 9
Beans, dry	7	May 15-June 15	Sept. 1	Sept. 10-Oct. 1	Oct. 15	Statewide
Broomcorn	38	May 20-July 1	Aug. 20	Sept. 10-Oct. 10	Nov. 1	3, 9
Corn,						
Grain	12	Apr. 15-June 1	Sept. 15	Oct. 10-Nov. 1	Dec. 1	1, 3, 7, 9
Silage	12	Apr. 15-June 1	Aug. 15	Sept. 1-Oct. 1	Nov. 1	1, 3, 7, 9
Forage	5	Apr. 15-June 1	Sept. 15	Oct. 1-Nov. 1	Dec. 1	1, 3, 7, 9
Cotton	201	Apr. 1-May 15	Sept. 25	Oct. 15-Nov. 20	Jan. 1	3, 7, 9
Hay,						
Alfalfa	156		May 1		Oct. 20	1, 3, 7, 9
Clo-tim	15		July 1		Aug. 15	1, 3
Oats,						
Fall sown	9	Sept. 1-Oct. 15	June 15	June 20-July 5	July 15	1, 3, 9
Spring sown		Feb. 15-Apr. 15	July 1	July 5-July 25	Aug. 15	1, 3, 9
Peanuts for nuts	7.5	May 10-June 1	Oct. 1	Oct. 10-Oct. 25	Nov. 10	Roosevelt
Sorghum,						
Grain	188	May 10-July 10	Oct. 1	Oct. 10-Nov. 10	Dec. 1	3, 7, 9
Silage	20	May 10-June 20	Aug. 15	Sept. 5-Oct. 1	Oct. 20	3, 7, 9
Sugar Beets		Feb. 1-Mar. 15	Nov. 1	Nov. 10-Dec. 1	Dec. 15	Curry, Torrance, Santa Fe
Wheat,						
Winter	213	Sept. 1-Oct. 20	June 5	June 15-July 5	July 20	1, 3
SEED CROPS:						
Alfalfa	4.6		July 25	Aug. 15-Sept. 15	Oct. 1	1, 3, 9
Sudangrass	6		Sept. 20	Oct. 1-Oct. 25	Nov. 15	Roosevelt, Curry

Table 50.--New York: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley, Fall sown	19	Aug. 25-Sept. 10	July 15	July 20-July 30	Aug. 5	4, 8
Spring sown		Apr. 25-Aug. 5	Aug. 5	Aug. 10-Aug. 20	Sept. 1	Statewide
Beans, dry	97	May 25-June 25	Sept. 5	Sept. 20-Oct. 20	Oct. 25	4, 5, 7, 8
Buckwheat	14	June 25-July 30	Sept. 15	Sept. 20-Oct. 10	Oct. 30	4, 5, 7, 8
Corn, Grain	181	May 20-June 15	Oct. 15	Oct. 25-Nov. 15	Dec. 1	4, Cayuga
Silage	420	May 20-June 20	Sept. 5	Sept. 15-Oct. 5	Oct. 15	Statewide
Forage	9	May 20-June 20	Aug. 25	Sept. 1-Sept. 15	Sept. 20	Statewide
Hay, Alfalfa	1,052		June 1		Sept. 10	Statewide
Clo-tim	1,508		June 10		Sept. 5	Statewide
Oats	569	Apr. 20-May 25	Aug. 1	Aug. 10-Aug. 25	Sept. 10	Statewide
Rye	19	Aug. 20-Oct. 10	July 1	July 5-July 15	July 20	4, 9a
Soybeans	4	June 1-June 30	Oct. 1	Oct. 10-Oct. 20	Oct. 30	Seneca
Wheat, Winter	183	Sept. 5-Oct. 10	July 15	July 25-Aug. 10	Aug. 15	4, 5
SEED CROPS:						
Red Clover	9		Sept. 1	Sept. 15-Oct. 15	Oct. 20	2, 4, 5, 7, 8

Table 51.--North Carolina: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	66	Sept.20-Oct. 30	May 20	June 10-June 25	July 1	5, 8, 9
Corn,						
Grain	1,259	Apr. 5-June 5	Sept. 5	Oct. 5-Nov. 15	Jan. 10	Statewide
Silage	110	Apr. 5-June 5	Aug. 1	Aug. 10-Sept. 10	Oct. 1	2, 4, 5, 6, 8
Forage	51	Apr. 5-June 5	Aug. 5	Aug. 15-Sept. 1	Sept. 15	2, 5, 8, 9
Cotton	402	Apr. 10-May 20	Sept. 5	Sept.25-Nov. 1	Dec. 1	2, 3, 5, 6, 8, 9
Cowpeas for peas	7	May 1-July 15	Sept. 15	Oct. 1-Nov. 1	Nov. 15	3, 8, 9
Hay,						
Alfalfa	39		May 25		Sept. 30	1, 2, 4, 5, 8
Clo-tim	152		June 5		Aug. 20	1, 2, 4, 5
Lespedeza	206		July 25		Sept. 15	2, 5, 8
Oats	217	Sept.20-Oct. 30	May 25	June 10-June 25	July 5	2, 5, 8, 9
Peanuts for nuts	176	May 1-June 5	Sept. 15	Oct. 1-Oct. 20	Nov. 15	3, 6, 9
Rye	16	Aug. 20-Nov. 15	June 5	June 15-July 1	July 5	2, 5, 8, 9
Sorghum,						
Grain	48	May 1-July 1	Aug. 15	Sept. 5-Sept.30	Oct. 15	5, 8
Silage	11	May 1-July 1	July 25	Aug. 5-Sept. 15	Oct. 1	2, 5, 8
Soybeans	558	May 10-June 25	Oct. 10	Nov. 1-Nov. 25	Dec. 15	3, 6, 9
Tobacco,						
Type 11	191	May 1-June 1	July 15	Aug. 1-Sept. 5	Sept. 10	2, 5
" 12	234	Apr. 15-May 15	July 5	July 15-Aug. 15	Aug. 25	3, 6
" 13	58	Apr. 10-May 10	July 1	July 10-Aug. 10	Aug. 20	9
" 31	11	May 15-June 10	Aug. 1	Aug. 10-Sept. 15	Oct. 1	1, 4
Wheat, Winter	204	Sept.20-Nov. 15	June 5	June 15-July 1	July 5	2, 3, 5, 6, 8, 9
SEED CROPS:						
Lespedeza	51		Oct. 25	Nov. 1-Nov. 25	Dec. 15	2, 5, 6, 8

Table 52.--North Dakota: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	2,887	Apr. 15-June 5	July 25	Aug. 1-Aug. 15	Aug. 30	Statewide
Beans, dry		May 20-June 10	Sept. 5	Sept. 10-Sept. 25	Oct. 1	4
Corn, Grain	169	May 15-June 20	Oct. 1	Oct. 1-Oct. 15	Nov. 1	6, 9
Silage	709	May 15-June 20	Sept. 1	Sept. 5-Sept. 10	Sept. 25	Statewide
Forage	150	May 15-June 20	Sept. 1	Sept. 10-Sept. 25	Oct. 1	Statewide
Flaxseed	1,627	May 1-June 25	Aug. 10	Aug. 15-Sept. 15	Oct. 5	Statewide
Hay, Alfalfa	1,400		June 20		Sept. 25	Statewide
Wild	1,693		June 25		Oct. 15	Statewide
Oats	1,950	Apr. 15-June 1	July 25	Aug. 1-Aug. 15	Aug. 25	Statewide
Peas, dry	4	Apr. 15-May 30	Aug. 15	Aug. 20-Sept. 1	Sept. 10	3, 6
Rye	539	Sept. 1-Sept. 20	July 20	July 25-Aug. 5	Aug. 15	Statewide
Safflower		May 10-May 25	Sept. 25	Oct.10-Oct. 15	Oct. 20	1, 2, 4, 5, 7, 8
Sorghum, Silage	8	May 25-June 20	Aug. 25	Sept. 1-Sept. 15	Sept. 20	Statewide
Soybeans	67	May 25-June 10	Oct. 1	Oct. 5-Oct. 20	Oct. 25	Cass, Richland, Traill
Sugar Beets	53.9	May 15-June 15	Sept. 10	Sept. 10-Oct. 20	Oct. 25	Pembina, Walsh, Grand Forks, Cass, Traill, Richland, Williams, McKenzie
Wheat, Winter		Sept. 10-Oct. 10	July 15	Aug. 1-Aug. 20	Aug. 25	1, 4, 7
Durum	1,855	Apr. 10-May 30	Aug. 1	Aug. 5-Aug. 25	Sept. 5	2, 3, 5, 6, 9
Other Spring	3,597	Apr. 10-May 20	July 25	Aug. 1-Aug. 20	Aug. 30	Statewide
SEED CROPS:						
Alfalfa	16		Oct. 5	Oct. 10-Oct. 15	Oct. 30	Statewide
Sweetclover	11		Aug. 20	Aug. 25-Sept. 5	Sept. 20	3, 6, 9
Kentucky Bluegrass			June 25	July 1-July 5	July 5	5, 9
Smooth Broomgrass	1.5		July 10	July 15-Aug. 5	Aug. 15	6, 9
Crested Wheatgrass	6		Aug. 5	Aug. 20-Sept. 1	Sept. 5	1, 4, 7, 8

Table 53.--Ohio: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley,						
Fall sown	45	Sept. 5-Oct. 10	June 20	July 1-July 10	July 15	Statewide
Spring sown		Apr. 5-May 10	July 15	July 25-Aug. 5	Aug. 20	Northern half of State
Corn,						
Grain	2,663	May 5-June 10	Sept. 25	Oct. 15-Nov. 10	Dec. 1	Statewide
Silage	226	May 5-June 10	Aug. 20	Sept. 1-Sept. 20	Oct. 1	Statewide
Forage	19	May 5-June 10	Sept. 5	Sept. 20-Oct. 1	Oct. 15	Statewide
Hay,						
Alfalfa	792		June 1		Sept. 25	Statewide
Clo-tim	1,043		June 5		Sept. 1	Statewide
Oats	833	Apr. 1-May 5	July 10	July 20-Aug. 5	Aug. 15	Statewide
Popcorn	17.5	May 5-June 5	Oct. 1	Oct. 15-Nov. 1	Nov. 15	1, 2, 4, 5
Rye	31	Sept. 10-Oct. 20	June 25	July 5-July 15	July 20	Statewide
Soybeans	1,791	May 10-June 10	Sept. 20	Oct. 1-Oct. 15	Nov. 1	1, 2, 4, 5, 7, 8
Sugar Beets	25	Apr. 10-May 15	Oct. 1	Oct. 15-Nov. 1	Nov. 10	1, 2, 4
Tobacco,						
Type 31	10.6	May 20-June 25	Aug. 25	Sept. 5-Sept. 15	Sept. 25	8, Hamilton, Clermont
Type 42-44	4.2	May 25-June 25	Aug. 25	Sept. 5-Sept. 15	Sept. 25	Darke, Miami, Montgomery, Preble, Warren
Wheat,						
Winter	1,209	Sept. 20-Nov. 1	July 5	July 15-July 25	Aug. 5	Statewide
SEED CROPS:						
Alfalfa	3.5		Sept. 10	Sept. 20-Oct. 1	Oct. 20	1, 2, 4
Red Clover	135		Sept. 5	Sept. 15-Sept. 25	Oct. 15	Statewide
Alsike Clover	1		Aug. 1	Aug. 5-Aug. 10	Aug. 20	1, 2
Sweetclover	6.7		Aug. 5	Aug. 10-Aug. 15	Aug. 25	1, 2, 4
Timothy	30		Aug. 1	Aug. 10-Aug. 20	Sept. 1	Statewide

Table 54.--Oklahoma: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates: Begins	Most active	Ends	Principal producing areas and counties
Barley,						
Fall sown	547	Sept. 10-Nov. 5	June 1	June 5-June 20	July 1	1, 2, 3, 4, 5, 7, 8
Spring sown		Jan. 20-Mar. 15	June 1	June 5-June 20	July 1	1, 2, 3, 4, 5, 7, 8
Broomcorn,						
Standard	37	Apr. 15-June 1	July 15	July 20-Aug. 15	Sept. 10	Garvin, Grady, McClain, Stephens
Dwarf		May 25-June 10	Sept. 1	Sept. 10-Oct. 1	Oct. 10	Cimarron, Texas
Corn,						
Grain	123	Mar. 25-May 10	Sept. 1	Sept. 15-Oct. 15	Nov. 20	3, 5, 6, 8, 9
Silage	15	Mar. 25-May 10	July 1	July 10-Aug. 10	Aug. 20	3, 5, 6, 8, 9
Forage	5	Mar. 25-May 10	Aug. 25	Sept. 15-Oct. 15	Dec. 1	3, 5, 6, 8, 9
Cotton	612	May 1-June 10	Sept. 20	Oct. 1-Nov. 30	Dec. 15	4, 7
Cowpeas for peas	21	May 1-July 1	Aug. 15	Sept. 20-Oct. 25	Nov. 1	2, 5, 6, 7
Guar		May 15-June 15	Sept. 20	Sept. 25-Oct. 15	Oct. 20	4, 7
Hay,						
Alfalfa	418		Apr. 20		Oct. 20	Statewide
Lespedeza	87		Aug. 1		Sept. 20	3, 6, 8, 9
Wild	415		July 1		Aug. 10	2, 3, 5, 6, 8, 9
Peanut	44		Sept. 20		Dec. 1	5, 6, 7, 8, 9
Mung Beans	24	May 1-July 15	July 20	Aug. 15-Sept. 15	Oct. 25	3, 5
Oats,						
Fall sown	319	Sept. 10-Nov. 10	June 1	June 10-June 22	July 5	Statewide
Spring sown		Jan. 25-Mar. 15	June 1	June 10-June 22	July 5	Statewide
Peanuts for nuts	115	May 10-June 15	Sept. 20	Oct. 5-Nov. 15	Dec. 1	5, 6, 7, 8, 9
Rye	58	Sept. 1-Oct. 15	June 5	June 10-June 20	July 1	1, 2, 4, 5, 7
Safflower		Apr. 10-May 15	Aug. 5	Aug. 20-Sept. 5	Sept. 10	1
Sesame		May 15-June 15	Sept. 1	Sept. 5-Sept. 15	Oct. 1	7
Sorghum,						
Grain	658	Apr. 25-June 25	Aug. 25	Sept. 20-Nov. 5	Dec. 5	Statewide
Silage	84	Apr. 25-June 25	July 15	July 25-Sept. 1	Sept. 15	Statewide
Soybeans	171	May 10-June 10	Sept. 10	Sept. 15-Oct. 15	Nov. 25	3, 6, 8, 9
Wheat,						
Winter	3,741	Sept. 1-Oct. 25	June 1	June 10-June 20	July 1	1, 2, 4, 5, 7
SEED CROPS:						
Alfalfa	48		Aug. 15	Aug. 25-Sept. 25	Oct. 5	1, 4, 7
Sweetclover	4		June 25	July 1-Aug. 10	Aug. 20	2, 4, 5, 7
Lespedeza	6		Nov. 5	Nov. 10-Nov. 20	Nov. 30	2, 3, 6, 8, 9
Tall (Alta & Ky. 31) Fescue	0.8		June 15	June 20-July 1	July 5	3, 6, 9
Sudangrass	1.7		Sept. 10	Sept. 20-Oct. 5	Oct. 15	2, 5, 7, 8
Hairy Vetch	14		June 10	June 20-July 15	July 30	4, 5, 6, 7

Table 55.--Oregon: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley,						
Fall sown	407	Aug. 15-Feb. 1	July 5	July 15-Aug. 5	Aug. 15	1, 2, 3, 8
Spring sown		Feb. 15-May 15	July 25	Aug. 5-Aug. 20	Sept. 15	Statewide
Corn,						
Grain	20	May 5-June 10	Sept.15	Sept. 25-Oct. 10	Oct. 20	Umatilla, Malheur, Josephine
Silage	27	May 5-June 10	Sept. 1	Sept. 5-Sept. 15	Sept. 20	1, Umatilla, Malheur, Josephine, Coos
Hay,						
Alfalfa	360		May 5		Sept. 15	Statewide
Clo-tim	184		June 5		Aug. 15	1, 7
Wild	225		June 5		Sept. 1	2, 3, 8
Oats,						
Fall sown	169	Oct. 5-Feb. 15	July 10	July 25-Aug. 15	Aug. 31	Statewide
Spring sown		Feb. 15-Apr. 15	Aug. 10	Aug. 20-Sept. 1	Sept. 10	Statewide
Peas,						
Dry	16	Feb. 20-Mar. 15	July 5	July 10-July 20	Aug. 1	Umatilla, Union, Wallowa
Rye	17	Sept. 1-Feb. 1	July 10	July 15-Aug. 20	Aug. 30	Statewide
Sugar Beets	19.6	Mar. 10-Apr. 15	Sept.10	Sept. 25-Oct. 15	Nov. 1	Umatilla, Malheur
Wheat,						
Winter	597	Aug. 15-Feb. 1	July 1	July 10-Aug. 15	Sept. 15	Statewide
Spring	83	Feb. 1-Apr. 15	Aug. 15	Aug. 25-Sept. 10	Sept. 15	Statewide
SEED CROPS:						
Alfalfa	17		Sept.15	Sept. 20-Oct. 10	Oct. 20	3, 8, Jackson
Red Clover	17		Sept. 5	Sept. 10-Oct. 1	Nov. 1	1 (except coast), Baker, Union, Jackson, Jefferson, Malheur
Alsike Clover	0.6		Sept. 1	Sept. 10-Sept. 25	Oct. 1	Multnomah, Yamhill, Deschutes, Jefferson, Klamath, Malheur
White Clover (Including Ladino)	2.1		Aug. 10	Aug. 25-Sept. 5	Sept. 15	Benton, Linn, Marion, Union, Wallowa, Jefferson, Malheur
Merion Kentucky Bluegrass	7		June 20	June 25-July 10	July 15	1 (except coast), Union, Jackson, Jefferson
Chewings Fescue	20		July 1	July 5-July 15	July 20	1 (except coast), Union
Red Fescue	11		July 1	July 5-July 15	July 20	1 (except coast), Union, Jefferson
Tall (Alta & Ky. 31) Fescue	9		July 1	July 5-July 10	July 20	1 (except coast), Union
Bentgrass	23		Aug. 20	Aug. 30-Sept. 10	Sept. 15	1, Union, Jackson, Jefferson, Klamath
Austrian Winter Peas	8.5		July 10	July 20-July 30	Aug. 5	1 (except coast), Union Douglas, Jackson, Jefferson, Klamath
Crimson Clover	17		June 15	June 25-July 1	July 10	1 (except coast)
Hairy Vetch	12		June 15	July 20-Aug. 1	Aug. 20	1 (except coast)
Common Vetch	8		July 15	July 20-Aug. 1	Aug. 20	1 (except coast), Jackson, Josephine, Douglas
All Ryegrass	152		July 10	July 15-July 25	Aug. 1	1 (except coast), Douglas

Table 30. Pennsylvania: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley, Fall sown	184	Sept. 10-Oct. 1	June 20	June 25-July 5	July 10	4, 5, 6, 7, 8, 9
Spring sown		Apr. 25-May 25	July 25	Aug. 1-Aug. 15	Aug. 20	1, 2, 3
Buckwheat	10	June 20-July 25	Sept. 15	Sept. 25-Oct. 15	Nov. 1	1, 2, 4, 7, Cambria, Clearfield
Corn, Grain	788	May 5-June 20	Sept. 20	Oct. 1-Oct. 20	Nov. 10	5, 8, 9
Silage	370	June 20-July 10	Sept. 5	Sept. 15-Sept. 25	Oct. 5	Statewide
Forage	11	June 20-July 10	Sept. 25	Oct. 1-Nov. 1	Dec. 5	Statewide
Hay, Alfalfa	771		May 20		Oct. 1	Statewide
Clo-tim	1,171		June 5		Sept. 25	Statewide
Soybean	2		Aug. 25		Sept. 25	9
Other	115		June 15		Sept. 25	Statewide
Oats, Fall sown	601	Sept. 1-Sept. 20	July 10	July 20-Aug. 1	Aug. 10	9
Spring sown		Apr. 10-May 25	July 25	Aug. 1-Aug. 20	Sept. 1	Statewide
Rye	18	Sept. 15-Oct. 15	July 1	July 15-July 25	Aug. 10	Statewide
Soybeans	9	May 15-July 1	Oct. 20	Nov. 1-Nov. 20	Dec. 1	9, Northampton, Northumberland, Montour
Tobacco, Type 41	30	May 25-July 1	Aug. 10	Aug. 25-Sept. 20	Oct. 1	Lancaster, Lebanon, York, Berks, Chester
Wheat, Winter	451	Sept. 15-Oct. 15	July 1	July 15-July 25	Aug. 10	4, 5, 6, 8, 9
SEED CROPS:						
Red Clover	12		Sept. 15	Oct. 1-Oct. 20	Nov. 1	1, 2, 4, 5, 7, 8
Timothy	4.5		Aug. 5	Aug. 10-Sept. 1	Sept. 15	1, 2, 4, 5, 7, 8

Table 57.--South Carolina: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	22	Oct. 1-Dec. 1	May 20	May 25-June 15	June 20	Statewide
Corn, Grain	487	Apr. 1-May 25	Sept. 15	Oct. 1-Dec. 5	Dec. 15	Statewide
Silage	20	Apr. 1-May 25	June 15	July 1-Aug. 1	Aug. 15	Statewide
Forage	34	Apr. 1-June 1	June 15	July 1-Sept. 1	Oct. 1	Statewide
Cotton	575	Apr. 10-May 20	Aug. 25	Sept. 5-Nov. 1	Nov. 15	Statewide
Cowpeas for peas	14	May 15-July 15	Sept. 15	Sept. 20-Oct. 25	Nov. 1	Aiken, Lexington, Orangeburg, Barnwell, Allendale, Bamberg
Hay, Lespedeza	46		Aug. 15		Sept. 30	Anderson, York, Spartanburg, Newberry, Greenville, Chester
Oats, Fall sown	199	Oct. 1-Dec. 1	May 20	May 25-June 15	June 20	Statewide
Spring sown		Jan. 15-Mar. 1	June 5	June 10-June 25	July 1	Statewide
Peanuts for nuts	11	Apr. 15-May 20	Sept. 1	Sept. 15-Oct. 1	Oct. 15	Sumter, Lee, Florence, Hampton, Barnwell, Aiken
Rye	16	Sept. 1-Dec. 5	May 25	June 1-June 15	June 20	Chesterfield, Orangeburg, Aiken, Bamberg, Hampton, Barnwell
Sorghum, Grain	6	June 1-June 25	Sept. 20	Sept. 25-Oct. 25	Nov. 15	Newberry, Anderson, Saluda, Chester, Spartanburg, Greenville
Silage	12	Apr. 15-July 1	Aug. 15	Aug. 20-Sept. 10	Sept. 15	
Soybeans	640	May 1-July 15	Oct. 20	Nov. 1-Dec. 1	Dec. 5	Orangeburg, Calhoun, Darlington, Lee, Allendale, Sumter
Tobacco, Type 13	84	Apr. 10-May 10	July 1	July 5-Aug. 10	Aug. 15	3, Clarendon
Wheat, Winter	56	Oct. 5-Dec. 20	June 5	June 15-July 1	July 5	Anderson, Orangeburg, Spartanburg, Calhoun, Laurens
SEED CROPS:						
Lespedeza	9		Nov. 5	Nov. 10-Nov. 25	Dec. 1	Anderson, Chesterfield, Spartanburg, Greenville, York, Laurens
Tall (Alta & Ky. 31) Fescue	4		June 20	June 25-July 10	July 20	Anderson, Laurens, Spartanburg, Greenville, Greenwood, Saluda
Lupine	3.5		June 1	June 5-June 15	June 20	Allendale, Barnwell, Hampton

Table 58.--South Dakota: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	409	Apr. 5-May 5	July 15	July 25-Aug. 5	Aug. 10	2, 3, 5, 6, 8, 9
Corn,						
Grain	2,659	May 5-June 1	Oct. 5	Oct. 20-Nov. 5	Nov. 15	2, 3, 5, 6, 9
Silage	470	May 10-June 10	Aug. 25	Sept.10-Sept. 20	Oct. 1	Statewide
Forage	116	May 5-June 10	Sept. 1	Sept.20-Oct. 5	Oct. 10	Statewide
Flaxseed	577	Apr. 20-June 1	Aug. 5	Aug. 15-Aug. 25	Sept. 5	2, 3, 6
Hay,						
Alfalfa	2,092		June 5		Sept. 20	Statewide
Wild	2,305		July 10		Sept. 10	Statewide
Oats	2,590	Apr. 5-May 5	July 15	July 25-Aug. 5	Aug. 10	2, 3, 5, 6, 9
Rye	261	Sept. 1-Oct. 1	July 15	July 20-Aug. 1	Aug. 5	2, 3, 5, 6, 9
Sorghum,						
Grain	115	May 20-June 20	Oct. 1	Oct. 10-Oct. 25	Nov. 5	5, 6, 8, 9
Silage	86	May 20-June 20	Aug. 20	Sept. 5-Sept. 15	Sept. 25	Statewide
Soybeans	121	May 15-June 15	Oct. 1	Oct. 10-Oct. 20	Nov. 1	3, 6, 9
Sugar Beets	10.2	Apr. 20-May 15	Sept. 15	Sept.20-Oct. 5	Oct. 15	1, 5, 9
Wheat,						
Winter	448	Sept. 1-Oct. 1	July 10	July 15-July 25	Aug. 5	4, 5, 7, 8
Durum	144	Apr. 1-May 1	July 20	July 25-Aug. 10	Aug. 15	2, 3, 5, 6
Other Spring	1,129	Apr. 1-May 1	July 20	July 25-Aug. 10	Aug. 15	1, 2, 3, 5
SEED CROPS:						
Alfalfa	44		Sept. 10	Sept.25-Oct. 10	Oct. 20	2, 3, 4, 7, 8
Sweetclover	18		July 20	Aug. 1-Aug. 20	Sept. 1	3, 6, 8, 9
Kentucky Bluegrass			June 15	June 20-July 1	July 10	2, 3, 5, 6
Smooth Bromegrass	7		July 10	July 15-Aug. 1	Aug. 10	5, 6, 9
Crested Wheatgrass	7.5		July 15	July 20-Aug. 15	Aug. 25	1, 2, 5, 8

Table 60.--Texas: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	227	Sept. 10-Nov. 25	May 15	May 25-June 15	June 30	1n, 2n, 2s, 4
Broomcorn	25	Mar. 10-Apr. 25	June 25	July 1-July 15	July 25	Bee, Medina, Karnes, Live Oak, LaSalle
Corn, Grain	1,052	Mar. 5-May 10	Aug. 5	Aug. 15-Sept. 20	Oct. 20	4, 5n, 8n, 9
Silage	36	Mar. 5-May 10	June 10	June 25-Aug. 10	Aug. 20	1n, 4, 8n
Forage	38	Mar. 5-May 10	June 20	July 5-July 31	Aug. 5	4, 8n, 9
Cotton	6,500	Mar. 10-June 15	July 25	Sept. 5-Dec. 10	Jan. 10	Statewide
Cowpeas for peas	39	Mar. 15-June 20	May 25	July 1-Aug. 1	Aug. 20	1s, 3, 4, 5n, 5s, 10n
Flaxseed	25	Nov. 1-Dec. 20	May 1	May 15-June 1	June 10	8n, 8s, 10n
Hay, Alfalfa	155		May 1		Sept. 30	1n, 2n, 4, 6, 9
Wild	302		June 10		Sept. 25	Statewide
Oats	741	Sept. 10-Nov. 25	May 10	May 20-June 15	June 25	2s, 3, 4, 7, 8n
Peanuts for nuts	278	Apr. 1-Aug. 1	July 15	Sept. 1-Nov. 15	Dec. 15	3, 4, 8n, 10n
Popcorn		Apr. 1-May 1	July 20	July 25-Aug. 20	Sept. 1	Lamar, Fannin, Guadalupe
Rice	462	Mar. 25-June 1	July 15	Aug. 10-Sept. 15	Nov. 15	9
Rye	23	Sept. 1-Nov. 20	May 10	June 1-June 15	June 25	1n, 1s, 2n, 2s
Sorghum, Grain	5,154	Mar. 10-July 1	July 1	July 25-Nov. 1	Dec. 1	Statewide
Silage	150	Mar. 10-July 1	June 10	June 20-Aug. 1	Aug. 20	Statewide
Soybeans	60	June 5-July 10	Oct. 20	Nov. 1-Dec. 1	Dec. 25	1n, 1s, 5n
Wheat, Winter	2,731	Sept. 1-Nov. 20	May 25	June 2-June 25	July 5	1n, 2n, 2s, 4
SEED CROPS:						
Alfalfa	5		Aug. 1	Aug. 5-Sept. 1	Sept. 30	2n, 6
Sweetclover	10.5		July 1	July 5-July 25	Aug. 10	4, 5n, 8n
Sudangrass	25		Aug. 25	Oct. 1-Nov. 10	Nov. 25	1n, 1s
Hairy Vetch	43		May 25	June 5-June 20	July 5	4, 5n

Table 59.--Tennessee: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates: Begins	Most active	Ends	Principal producing areas and counties
Barley	35	Sept. 1-Nov. 1	May 25	June 1-June 20	July 1	3, 4, 5
Corn, Grain	961	Apr. 20-June 20	Sept. 25	Oct. 15-Nov. 15	Dec. 15	Statewide
Silage	54	Apr. 20-June 20	Aug. 1	Aug. 20-Sept. 20	Oct. 15	Statewide
Forage	28	Apr. 20-June 20	Sept. 15	Oct. 1-Nov. 1	Dec. 15	Statewide
Cotton	538	Apr. 20-May 25	Sept. 15	Sept. 25-Nov. 5	Dec. 5	1, 2, southern part of 3 & 4
Cowpeas for peas	5	May 10-June 25	Oct. 1	Oct. 15-Nov. 15	Dec. 10	1, 2
Hay, Alfalfa	177		May 1		Oct. 1	4, 5, 6
Clo-tim	235		May 1		June 20	3, 4, 5, 6
Lespedeza	474		Aug. 10		Sept. 20	Statewide
Oats, Fall sown	85	Sept. 1-Nov. 1	June 1	June 10-June 30	July 5	Statewide
Spring sown		Mar. 15-Apr. 15	Mostly for hay			4, 5, 6
Popcorn		Apr. 20-June 20	Oct. 1	Oct. 15-Nov. 10	Dec. 1	Henry, Montgomery, Stewart
Rye	9	Sept. 1-Oct. 20	June 1	June 10-July 1	July 5	3, 4, 5
Sorghum, Grain	20	June 1-June 30	Sept. 10	Sept. 20-Oct. 15	Nov. 1	1, 2, 3, 4, 5
Silage	13	May 10-June 20	Aug. 20	Sept. 1-Sept. 30	Oct. 15	Statewide
Soybeans	463	May 10-June 25	Oct. 1	Oct. 15-Nov. 20	Dec. 10	1, 2
Tobacco, Type 22	14	May 10-June 15	Aug. 20	Aug. 25-Sept. 20	Oct. 1	Cheatham, Dickson, Montgomery, Robertson, Stewart
Type 23	1.4	May 10-June 15	Aug. 20	Aug. 25-Sept. 20	Oct. 1	Henry, Weakley
Type 31	67	May 10-June 15	Aug. 15	Aug. 20-Sept. 15	Oct. 1	3, 4, 5, 6
Type 35	2.1	May 10-June 15	Aug. 20	Aug. 25-Sept. 20	Oct. 1	Macon, Robertson, Sumner, Weakley
Wheat, Winter	107	Oct. 10-Nov. 30	June 10	June 15-July 5	July 15	Statewide
SEED CROPS:						
Lespedeza	37		Oct. 20	Nov. 5-Nov. 25	Dec. 1	1, 2, 3, 4, 5
Tall (Alta & Ky. 31) Fescue	20		June 15	June 20-July 5	July 15	3, 4
Crimson Clover	8.5		May 25	June 1-June 10	June 15	(South Central)

Table 61.--Utah: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	155	Mar. 20-Apr. 25	Aug. 1	Aug. 10-Sept. 5	Sept. 15	Statewide
Beans, dry	8	May 10-May 25	Sept. 1	Sept. 10-Oct. 10	Oct. 20	San Juan
Corn, Grain	3	May 10-June 10	Sept. 1	Sept. 15-Oct. 10	Oct. 15	Davis, Utah, Duchesne, Emery, Weber
Silage	38	May 10-June 10	Aug. 1	Aug. 5-Aug. 25	Sept. 1	Statewide
Hay, Alfalfa	443		May 15		Oct. 25	Statewide
Clo-tim	43		July 1		Aug. 31	6
Wild	65		July 15		Aug. 15	Rich, Sanpete, Utah
Grain and other	18		July 15		Aug. 1	Millard, Cache, Utah
Oats	26	Mar. 20-May 10	Aug. 1	Aug. 15-Sept. 15	Sept. 25	Box Elder, Cache, Duchesne, Sanpete, Uintah, Utah, Weber
Safflower		Apr. 10-Apr. 25	Sept. 20	Sept. 25-Oct. 10	Oct. 15	1, 7
Sugar Beets	24	Mar. 20-May 20	Sept. 1	Sept. 10-Nov. 10	Nov. 20	Box Elder, Cache, Salt Lake, Weber, Sevier, Utah
Wheat, Winter	148	Sept. 1-Sept. 25	July 15	July 25-Aug. 15	Sept. 1	Box Elder, Cache, San Juan, Salt Lake, Millard, Juab
Spring	41	Mar. 20-Apr. 30	Aug. 5	Aug. 10-Sept. 1	Sept. 10	Cache, Box Elder, Utah, Salt Lake
SEED CROPS:						
Alfalfa	40		Aug. 15	Aug. 25-Oct. 10	Oct. 20	Millard, Box Elder, Cache, Duchesne, Uintah

Table 82.--Virginia: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	112	Sept. 5-Nov. 1	June 1	June 20-July 1	July 15	2, 4, 5, 6
Corn, Grain	534	Apr. 15-June 25	Sept. 1	Oct. 1-Nov. 10	Dec. 1	Statewide
Silage	103	May 1-July 1	Aug. 15	Sept. 1-Sept. 20	Oct. 10	2, 5, 7
Forage	13	May 1-July 1	Aug. 15	Sept. 1-Sept. 20	Oct. 1	2, 5, 7
Cotton	14.8	Apr. 15-May 25	Sept. 15	Sept. 25-Nov. 1	Dec. 10	9
Hay, Alfalfa	250		May 1		Oct. 20	2, 4, 7
Clo-tim	483		May 25		Aug. 10	2, 4, 5, 7
Lespedeza	216		Aug. 1		Oct. 1	2, 5, 8
Oats, Fall sown	81	Sept. 1-Oct. 25	June 1	June 10-July 1	July 10	5, 6, 8, 9
Spring sown		Feb. 1-Apr. 15	June 15	July 1-July 15	July 20	2, 4, 7, 8
Peanuts for nuts	104	May 5-June 5	Sept. 20	Oct. 1-Nov. 25	Dec. 10	9
Rye	19	Sept. 1-Dec. 1	June 1	June 15-July 1	July 5	6, 9
Sorghum, Grain	7	May 10-July 1	Sept. 25	Oct. 1-Nov. 5	Nov. 25	9
Silage	8	May 15-July 1	Sept. 1	Sept. 15-Oct. 1	Oct. 15	2
Soybeans	389	May 1-July 10	Oct. 1	Oct. 25-Nov. 25	Dec. 5	5, 6, 9
Tobacco, Type 11	73.5	May 5-June 5	July 15	Aug. 10-Sept. 5	Sept. 20	8, 9
Type 21	7.6	May 15-June 15	Aug. 15	Aug. 25-Sept. 15	Sept. 25	5, 8
Type 31	12.1	May 15-June 20	Aug. 15	Aug. 25-Sept. 20	Oct. 1	7
Type 37	2.2	May 15-June 15	Aug. 15	Aug. 25-Sept. 15	Sept. 25	5
Wheat, winter	179	Sept. 25-Dec. 1	June 10	June 20-July 10	July 15	2, 5, 6, 8
SEED CROPS:						
Red Clover	10		Aug. 15	Aug. 20-Aug. 30	Sept. 15	2, 5, 6
Lespedeza	9		Sept. 25	Oct. 20-Nov. 10	Dec. 1	5, 6, 8
Orchardgrass	27		June 10	June 25-July 15	July 25	Loudoun, Fauquier, Page

Table 63.--Washington: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley, Fall sown	621	Sept. 5-Nov. 10	July 1	July 15-Aug. 10	Aug. 20	2, 3, 5, 9
Spring sown		Mar. 10-Apr. 1	July 5	July 20-Aug. 15	Sept. 1	2, 3, 5, 9
Beans, dry	31	May 1-June 10	Aug. 15	Sept. 5-Sept. 30	Nov. 1	5
Corn, Grain	30	May 5-June 5	Oct. 15	Oct. 25-Nov. 20	Dec. 15	2, 5
Silage	31	May 5-June 5	Sept. 5	Sept. 10-Oct. 5	Oct. 15	1, 2, 5
Forage	1	May 5-June 5	Oct. 1	Oct. 5-Oct. 25	Nov. 1	1, 2, 5
Hay, Alfalfa	427		June 1		Sept. 15	Statewide
Clo-tim	229		May 25		Sept. 5	Statewide
Wild	43		June 1		Sept. 15	Statewide
Oats	105	Mar. 10-Apr. 20	July 15	Aug. 1-Aug. 25	Sept. 10	Statewide
Peas, dry	178	Apr. 1-Apr. 25	July 10	July 25-Aug. 25	Sept. 1	Whitman, Spokane, Grant
Rye	81	Aug. 10-Nov. 1	July 5	July 20-Aug. 15	Sept. 1	2, 5
Sugar Beets	55.5	Mar. 1-Mar. 31	Sept. 20	Oct. 10-Nov. 10	Nov. 20	2, 5, 9
Wheat, Winter	1,486	Aug. 15-Nov. 20	July 5	July 20-Aug. 15	Sept. 20	2, 3, 5, 9
Spring	211	Mar. 10-Apr. 10	July 15	July 25-Aug. 20	Sept. 30	2, 3, 5, 9
SEED CROPS:						
Alfalfa	25		Sept. 5	Sept. 15-Oct. 15	Oct. 30	2, 5, 9
Red Clover	3.7		Sept. 1	Sept. 10-Oct. 10	Oct. 25	5
Merion Kentucky Bluegrass	5.6		July 10	July 25-Aug. 15	Sept. 1	Spokane, Whitman
Red Fescue	0.7		July 10	July 25-Aug. 15	Sept. 1	Spokane
Bentgrass	0.4		Aug. 5	Aug. 20-Sept. 5	Sept. 25	1

Table64.-- West Virginia: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acres (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	10	Sept. 15-Oct. 20	June 25	July 1-July 25	Aug. 1	6
Corn, Grain	71	May 1-June 5	Sept. 15	Sept. 25-Oct. 20	Nov. 1	Statewide
Silage	26	June 1-June 20	Aug. 25	Sept. 1-Sept. 10	Sept. 10	Statewide
Hay, Alfalfa	127		May 25		Sept. 10	Statewide
Clo-tim	341		June 1		Aug. 30	Statewide
Lespedeza	9		Aug. 15		Sept. 20	Statewide
Other	148		June 15		Sept. 10	Statewide
Oats	24	Apr. 10-May 20	July 15	July 25-Aug 10	Aug. 20	Statewide
Tobacco, Type 31	2.8	May 25-June 25	Aug. 25	Sept. 1-Sept.25	Sept. 25	Cabell, Lincoln, Mason, Putnam
Wheat, Winter	18	Sept. 25-Oct. 20	July 10	July 15-Aug. 5	Aug. 10	6, Preston, Mason

Table 65.--Wyoming: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acres (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	112	Apr. 5-May 20	Aug. 1	Aug. 5-Aug. 20	Aug. 30	Statewide
Beans, dry	52	May 10-June 15	Sept. 10	Sept. 15-Oct. 10	Oct. 10	1, 5
Corn, Grain	8	May 10-June 15	Oct. 15	Nov. 1-Nov. 15	Nov. 30	1, 2, 5
Silage	39	May 10-June 15	Aug. 20	Aug. 20-Sept. 5	Sept. 15	1, 2, 5
Forage	9	May 10-June 15	Sept. 15	Oct. 1-Oct. 30	Nov. 30	1, 2, 5
Hay, Alfalfa	468		June 10		Sept. 5	1, 2, 3, 5
Clo-tim	130		July 1		Aug. 15	1, 2, 3, 5
Wild	444		July 15		Sept. 5	Statewide
Other tame	80		July 1		Sept. 5	Statewide
Oats	94	Apr. 5-May 20	Aug. 1	Aug. 10-Aug. 25	Aug. 30	1, 2, 5
Rye	7	Aug. 20-Sept. 30	July 20	July 30-Aug. 10	Aug. 15	5
Sugar beets	48.7	Apr. 5-May 20	Oct. 5	Oct. 10-Oct. 25	Oct. 30	1, 5
Wheat, Winter	187	Aug. 20-Sept. 30	July 20	Aug. 10-Aug. 20	Sept. 5	2, 5
Spring	26	Apr. 5-May 10	Aug. 1	Aug. 10-Aug. 25	Aug. 30	1, 2, 5
SEED CROPS:						
Alfalfa	3.5		Aug. 20	Sept. 10-Oct. 15	Oct. 30	1, 2
Crested Wheatgrass	2		Aug. 1	Aug. 10-Aug. 25	Sept. 1	5

Table 66.--Wisconsin: Usual planting and harvesting dates by crops and principal producing areas

Crop	1962 harvested acreage (000)	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
			Begins	Most active	Ends	
Barley	30	Apr. 15-May 15	July 15	July 20-July 30	Aug. 15	Rock, Walworth, Dodge, Fond du Lac, Racine
Buckwheat	6	May 1-July 1	Aug. 20	Aug. 25-Sept. 5	Sept. 15	Fond du Lac, Dodge, Columbia, Waushara, Eau Claire
Corn,						
Grain	1,533	May 5-June 15	Sept. 25	Oct. 5-Oct. 30	Nov. 15	Statewide
Silage	985	May 5-June 25	Aug. 25	Sept. 5-Sept. 15	Oct. 1	Statewide
Forage	17	May 5-June 20	Sept. 1	Sept.10-Oct. 1	Oct. 15	Statewide
Flaxseed	4	Apr. 15-May 15	July 20	July 25-July 30	Aug. 15	Ozaukee, Sheboygan, Pierce, Brown, Bayfield
Hay,						
Alfalfa	2,929		June 15		Sept. 10	Statewide
Clo-tim	901		June 15		Sept. 10	Statewide
Wild	25		July 5		Aug. 5	Portage, Dodge, Marquette, Green Lake, Waushara
Oats	2,229	Apr. 10-May 10	July 15	July 20-July 30	Aug. 15	Statewide
Rye	23	Sept. 5-Oct. 1	July 10	July 20-July 30	Aug. 10	Portage, Dunn, Waushara, Marquette, Adams
Soybeans	101	May 20-July 1	Sept. 25	Oct. 5-Oct. 20	Nov. 1	Dunn, Trempealeau, Pepin, Eau Claire, Racine, Walworth, Kenosha
Tobacco,						
Type 54	4.9	May 25-June 15	Aug. 20	Sept. 1-Sept. 10	Sept. 20	Dane, Rock, Columbia
Type 55	7.2	June 1-June 20	Aug. 20	Sept. 1-Sept. 10	Sept. 20	Vernon, Crawford, Monroe, Richland, LaCrosse
Wheat,						
Winter	31	Sept. 5-Oct. 1	July 10	July 20-July 30	Aug. 10	Racine, Washington, Kenosha, Walworth, Ozaukee
Spring	17	Apr. 10-May 10	July 15	July 20-July 30	Aug. 15	Sheboygan, Ozaukee, Walworth, Dane, Dodge
SEED CROPS:						
Alfalfa	4		Aug. 25	Sept. 10-Sept. 20	Oct. 5	Brown, Bayfield, Calumet, Outagamie, Kewaunee
Red Clover	42		Sept. 1	Sept. 10-Sept. 20	Oct. 1	Statewide
Timothy	7.2		Aug. 1	Aug. 5-Aug. 15	Sept. 1	Statewide

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Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

FOOD PURCHASING GUIDE FOR GROUP FEEDING

Prepared by

BETTY PETERKIN and BEATRICE EVANS

Consumer and Food Economics Research Division
Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Agriculture Handbook No. 284

This handbook is an expansion and revision of
Appendix E of "Planning Food for Institutions,"
Agriculture Handbook No. 16, U.S. Department of Agriculture

PREFACE

This Handbook presents information helpful to food managers in estimating quantities of foods to be purchased for group feeding in small and large institutions. Data for food items, including many of the new market forms, are presented for purchase units most commonly used. The latest information on yields from the weight "as purchased" to the weight "as served" was used to derive the estimated number of portions of specified sizes from a purchase unit and the approximate number of purchase units needed to serve 25 and 100 persons.

ACKNOWLEDGMENTS

Yield and weight data were developed in coopertion with the School Lunch Division, Consumer and Marketing Service, and the Human Nutrition Research Division, Agricultural Research Service, both of the U.S. Department of Agriculture, and the Fish and Wildlife Service of the U.S. Department of the Interior. Basic yield and weight data for many foods used in the preparation of this buying guide for institutions were also used in the preparation of a buying guide including foods and serving sizes appropriate for school lunches under the National School Lunch Program, "Food Buying Guide for Type A School Lunches," Program Aid 270, U.S. Department of Agriculture, Revised January 1964.

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USDA ACCEPTANCE SERVICE FOR QUANTITY BUYERS

The Consumer Marketing Service of the U.S. Department of Agriculture offers a special "acceptance service" to assist food buyers in obtaining large volumes of food products tailored to meet their specific needs. This service can be used in purchasing fresh and processed fruits and vegetables, meats and meat products, poultry and eggs, and dairy products. For further information, write to Deputy Administrator, Marketing Services, Consumer and Marketing Service, U.S. Department of Agriculture, Washington, D.C., 20250.

CONTENTS

	Page
troduction	1
xplanation of terms used	1
uantities to purchase for 25 and 100 portions	3
Table 1.—Meat	3
Table 2.—Combination foods containing meat	8
Table 3.—Poultry	10
Table 4.—Combination foods containing poultry	12
Table 5.—Fish and shellfish	13
Table 6.—Eggs	16
Table 7.—Nuts	17
Table 8.—Dairy products	18
Table 9.—Vegetables—fresh	20
Table 10.—Vegetables—canned	23
Table 11.—Vegetables—frozen	26
Table 12.—Vegetables—dried	28
Table 13.—Fruits—fresh	29
Table 14.—Fruits—canned	32
Table 15.—Fruits—frozen	34
Table 16.—Fruits—dried	36
Table 17.—Flour, cereals, and mixes	37
Table 18.—Bakery foods	40
Table 19.—Fats and oils	41
Table 20.—Sugar and sweets	42
Table 21.—Beverages	43
Other useful information for estimating food quantities	44
Table 22.—Conversion factors for computing the number of purchase units needed for portions of various sizes	44
Table 23.—Cost per portion for food priced from 10 cents to $2 per purchase unit	44
Table 24.—Beef: Approximate percentage edible meat from the carcass and wholesale cuts of Choice, Good, and Standard grades of beef	45
Table 25.—Lamb: Approximate percentage edible meat from the carcass and wholesale cuts of Prime, Choice, and Good grades of lamb	45
Table 26.—Pork: Approximate percentage edible meat from the carcass and wholesale trimmed cuts from hogs of three weight groups	45
Table 27.—Vegetables and fruits: Approximate amount of canned and frozen product obtained from specified quantities of fresh vegetables and fruits	46
Table 28.—Common can and jar sizes	48
Ounce equivalents in decimal parts of pound	48
Approximate scoop equivalents	48
Common food-measure equivalents	48
Government publications available	49
Index of foods in tables 1 though 21	51

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FOOD PURCHASING GUIDE FOR GROUP FEEDING

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INTRODUCTION

This food purchasing guide contains informa- ion useful in estimating the number of purchase nits of foods to buy to serve a specific number of ortions.

Foods have been listed by major groups in ables 1 through 21. Within each group the ndividual foods are arranged alphabetically. For ach purchase unit specified, these data are given: Veight of the unit of purchase, yield from weight as purchased" to weight "as served," size and escription of portion, number of portions from ach purchase unit, and the approximate number f purchase units needed for 25 and 100 portions.

Table 22 presents an easy method for computing ne number of purchase units needed for portions of sizes other than those given in tables 1 through 21. Table 23 gives an easy method for finding the cost of a portion of food.

The yields of edible meat from the carcass of wholesale cuts of beef, lamb, and pork given in tables 24 to 26 are useful to institutions that raise their own meat animals or purchase meat by the carcass or wholesale cuts. The yields of canned and frozen products from fresh vegetables and fruits given in table 27 are useful to institutions that produce and preserve their own vegetables and fruits.

Table 28 gives the common can and jar sizes, and on page 48 equivalents used frequently by food planners are given.

EXPLANATION OF TERMS USED

Food as purchased.—Foods are described in the rms as purchased—fresh, frozen, canned, dried. urther descriptive information that would affect ne yield is also given, such as: for meats—bone in, one out; for carrots—with tops, without tops; nd for potatoes—to be pared, ready-to-cook.

Unit of purchase.—Sizes of cans, packages, or her containers and weights of units in common se in the wholesale and retail markets are given. sually, data for the 1-pound unit are given; from nese the yield of any weight purchase unit can be etermined.

Weight per unit.—Weights given for purchase nits refer to weights as purchased on the market. egal weights for contents of such units as bushels, gs, crates, and boxes may vary in different tates. The lowest of these weights is used to sure that the specified portions can be obtained. Veights for canned goods are the same as those ven as net weight on the label.

Yield as served.—Yield as served refers to the eight of food "as served" as a percentage of eight "as purchased." Absence of information this column means a weight yield was not used determine the number of portions per purchase nit.

The same item "as purchased" may have more nan one yield, depending on the way it is served. For example, 1 pound of fresh carrots without tops will yield 0.75 pound cooked and 0.82 pound grated raw.

The yield does not always refer to a serving that is all edible. For example, because pork chops are usually served with bone, the yield given is the percentage of the "as purchased" weight represented by the cooked chop with the bone in. On the other hand, the yield of the chuck roast, usually served without bone, is the percentage of the chuck "as purchased"—that is, cooked and served without the bone. For meats, the yield of cooked lean is given in an additional column.

The amount of ready-to-serve food obtained from a given amount of food "as purchased" may vary widely, depending on the size, grade, and general condition of the food, discards in preparation, and the method and time of cooking. For yields given in this Handbook, it is assumed that the food used is in good condition (free of rot, insect infestation, bruising), that only usual amounts are discarded in preparation, and that usual cooking methods and time of cooking for the food specified are used.

For yields given, discard of inedible material such as bones, pits, and shells, except where otherwise specified, is assumed. Also assumed as discard are some foods that could be eaten but are usually discarded, such as potato parings and outer leaves of vegetables.

The yields presented in these tables were obtained from Agriculture Handbook No. 102, "Food Yields Summarized by Different Stages of Preparation," and unpublished data from the Agricultural Research Service of the U.S. Department of Agriculture and from the Fish and Wildlife Service of the U.S. Department of the Interior. Yields for commercially prepared meat combinations (table 2) are based on minimum meat requirements for meat food products packed for interstate shipment under Federal inspection. Contents of cooked poultry meat in poultry products are based on regulations governing the inspection of poultry and poultry products, effective January 1, 1965.

Size and description of portion.—Weight or volume of portion commonly used is given. This portion for most foods refers to the amount served. For foods often used in combination with other foods, such as canned milk, nonfat dry milk, eggs, nuts, flour, and uncooked cereals, a portion refers to a measure commonly called for in institution recipes.

For meat, poultry, and fish, data for two sizes of portions are given. The larger portion may be appropriate for an adult serving; the smaller may be sufficient for a child's meal or a luncheon menu. The size of meat portions is given (1) in ounces of cooked meat as served including fat and, in some cases, bone; and (2) in ounces of cooked lean only.

For vegetables and fruits, the portion size is generally the weight of ½ cup rounded to the nearest ounce. It is assumed that canned, cooked fresh, and cooked dried fruits are served with sirup, and that heated canned vegetables and cooked fresh and frozen vegetables are served drained. It is assumed that solid-pack fruits are served without liquid.

Institutions that use a different portion size than those given may adjust the amount to purchase by the method given in table 22.

Portions per purchase unit.—In obtaining the portions per purchase unit or the yield of a purchase unit in portions, average quantities of refuse and usual weight losses in cooking are assumed. The number of portions may vary from that shown if the condition of the food purchased is poor or unusual waste occurs in preparation and cooking.

To obtain the number of units to purchase, the number of portions per purchase unit can be divided into the number of persons to be served. This may be the most practical method of computing the amount to purchase if the institution does not serve 25 or 100 persons or easy multiples of these numbers of persons.

For example, if 1 pound of meat will serve 2.5 portions of the size desired, the food manager of an institution serving 580 persons may divide 580 by 2.57 to get the amount of meat needed—226 pounds. It is because of such use of these figures and not because the figures represent this degree of accuracy, that they have been carried to the nearest one-hundredth of a portion. Had the portions per pound of meat been rounded to the nearest number of portions per pound (3), the food manager would purchase only 193 pounds of meat—33 pounds short of the best estimate of his needs.

The number of portions per purchase unit can be used with the cost of the purchase unit and table 23 in obtaining the cost for one portion.

Approximate purchase units for 25 and 100 portions.—These columns represent 25 and 100 divided by the number of portions per purchase unit in the preceding column. The resulting number of purchase units is always carried to the next even one-quarter (¼) unit. Thus, the number of purchase units specified is always sufficient if the yield and portion size are as shown in the table. If the purchase units serve many portions such as a bushel of apples or a No. 10 can of vegetables, this ¼ purchase unit may be very significant. If the purchase unit serves few portions as in the case of a pound of meat, the ¼ purchase unit is relatively unimportant.

TABLE 1.—MEAT

Meat as purchased	Unit of purchase	Yield, cooked		Description of portion as served	Size of portion		Portions per purchase unit	Approximate purchase units for—	
		As served	Lean only		As served	Lean only		25 portions	100 portions
BEEF, FRESH OR FROZEN		*Percent*	*Percent*		*Ounces*	*Ounces*	*Number*	*Number*	*Number*
Brisket:									
Corned, bone out	Pound	60	41	Simmered	4	2.8	2.40	10½	41¾
					3	2.1	3.20	8	31¼
Fresh:									
Bone in	do	52	36	Simmered, bone out	4	2.8	2.08	12¼	48¼
					3	2.1	2.77	9¼	36¼
Bone out	do	67	46	Simmered	4	2.8	2.68	9½	37½
					3	2.1	3.57	7¼	28¼
Ground beef:									
Lean	do	75	75	Broiled	3	3.0	4.00	6¼	25
					2	2.0	6.00	4¼	16¾
Regular	do	72	72	Pan-fried	3	3.0	3.84	6¾	26¼
					2	2.0	5.76	4½	17½
Heart	do	39	39		2	2.0	3.12	8¼	32¼
Kidney	do	39	39		2	2.0	3.12	8¼	32¼
Liver	do	69	69	Braised	3	3.0	3.68	7	27¼
					2	2.0	5.52	4¾	18¼
Oxtails	do	29	29		(1)	(1)	(1)	(1)	(1)
Roasts:									
Chuck:									
Bone in	do	52	42	Roasted, moist heat, bone out	4	3.2	2.08	12¼	48¼
					3	2.4	2.77	9¼	36¼
Bone out	do	67	54	Roasted, moist heat	4	3.2	2.68	9½	37½
					3	2.4	3.57	7¼	28¼
7-Rib (shortribs removed):									
Bone in	do	65	42	Roasted, dry heat, bone out	4	2.6	2.60	9¾	38½
					3	1.9	3.47	7¼	29
Bone out	do	73	47	Roasted, dry heat	4	2.6	2.92	8¾	34¼
					3	1.9	3.89	6½	25¾
Round:									
Bone in	do	69	56	Roasted, dry heat, medium, bone out	4	3.3	2.76	9¼	36¼
					3	2.5	3.68	7	27¼
Bone out	do	73	60	Roasted, dry heat, medium	4	3.3	2.92	8¾	34¼
					3	2.5	3.89	6½	25¾
Rump:									
Bone in	do	58	43	Roasted, dry heat, bone out	4	3.0	2.32	11	43¼
					3	2.2	3.09	8¼	32½
Bone out	do	73	55	Roasted, dry heat	4	3.0	2.92	8¾	34¼
					3	2.2	3.89	6½	25¾
Shortribs	do	67	32	Braised, bone in	6	2.9	1.79	14	56
					4	1.9	2.68	9½	37½

See footnotes at end of table.

TABLE 1.—MEAT—Continued

Meat as purchased	Unit of purchase	Yield, cooked		Description of portion as served	Size of portion		Portions per purchase unit	Approximate purchase units for—	
		As served	Lean only		As served	Lean only		25 portions	100 portions
BEEF, FRESH OR FROZEN—Continued									
Steaks:		*Percent*	*Percent*		*Ounces*	*Ounces*	*Number*	*Number*	*Number*
Club:									
Bone in	Pound	73	33	Broiled, bone in	6	2.7	1.95	13	51½
					4	1.8	2.92	8¾	34¼
Bone out	do	73	42	Broiled	4	2.3	2.92	8¾	34¼
					3	1.7	3.89	6½	25¾
Flank	do	67	67	Braised	3	3.0	3.57	7¼	28¼
					2	2.0	5.36	4¾	18¾
Hip:									
Bone in	do	73	32	Broiled, bone in	6	2.6	1.95	13	51½
					4	1.8	2.92	8¾	34¼
Bone out	do	73	40	Broiled	4	2.2	2.92	8¾	34¼
					3	1.6	3.89	6½	25¾
Minute, cubed	do	75	75	Pan-fried	3	3.0	4.00	6¼	25
					2	2.0	6.00	4¼	16¾
Porterhouse:									
					8	4.0	1.46	17¼	68½
Bone in	do	73	36	Broiled, bone in	6	3.0	1.95	13	51½
					4	2.0	2.92	8¾	34¼
Bone out	do	73	42	Broiled	4	2.3	2.92	8¾	34¼
					3	1.7	3.89	6½	25¾
Round:									
Bone in	do	73	56	Broiled, bone in	4	3.1	2.92	8¾	34¼
					3	2.3	3.89	6½	25¾
Bone out	do	73	60	Broiled	4	3.3	2.92	8¾	34¼
					3	2.5	3.89	6½	25¾
Sirloin (wedge and round):									
Bone in	do	73	44	Broiled, bone in	6	3.6	1.95	13	51½
					4	2.4	2.92	8¾	34¼
Bone out	do	73	48	Broiled	4	2.6	2.92	8¾	34¼
					3	2.0	3.89	6½	25¾
T-bone:									
					8	3.8	1.46	17¼	68½
Bone in	do	73	34	Broiled, bone in	6	2.8	1.95	13	51½
					4	1.9	2.92	8¾	34¼
Bone out	do	73	41	Broiled	4	2.2	2.92	8¾	34¼
					3	1.7	3.89	6½	25¾
Stew meat (chuck), bone out	do	67	54	Cooked, moist heat	3	2.4	3.57	7¼	28¼
					2	1.6	5.36	4¾	18¾
Tongue:									
Fresh	do	59	59	do	3	3.0	3.15	8	31¾
					2	2.0	4.72	5½	21¼
Smoked	do	51	51	do	3	3.0	2.72	9¼	37
					2	2.0	4.08	6¼	24¾

BEEF, CANNED[1]									
Beef, corned	-----do-------	100	100	Heated	{ 3	3.0	5.33	4¾	19
					{ 2	2.0	8.00	3¼	12½
	6-pound can	100	100	-----do-------	3	3.0	32.00	1	3¼
BEEF, DRIED									
Beef, chipped	Pound	125	125	Cooked, moist heat	{ 3	3.0	6.67	3¾	15
					{ 2	2.0	10.00	2½	10
LAMB, FRESH OR FROZEN									
Chops:									
Loin	-----do-------	76	41	Broiled, bone in	5.0	2.7	2.43	10½	41¼
Rib	-----do-------	76	34	-----do-------	5.0	2.2	2.43	10½	41¼
Shoulder	-----do-------	70	41	-----do-------	5.0	2.9	2.24	11¼	44¾
Ground lamb	-----do-------	68	68	Broiled patties	{ 3.0	3.0	3.63	7	27¾
					{ 2.0	2.0	5.44	4¾	18½
Roasts:									
Leg:									
Bone in	-----do-------	54	45	Roasted, bone out	{ 4.0	3.3	2.16	11¾	46½
					{ 3.0	2.5	2.88	8¾	34¾
Bone out	-----do-------	70	58	Roasted	{ 4.0	3.3	2.80	9	35¾
					{ 3.0	2.5	3.73	6¾	27
Shoulder:									
Bone in	-----do-------	55	41	Roasted, bone out	{ 4.0	3.0	2.20	11½	45½
					{ 3.0	2.2	2.93	8¾	34¼
Bone out	-----do-------	70	52	Roasted	{ 4.0	3.0	2.80	9	35¾
					{ 3.0	2.2	3.73	6¾	27
Stew meat,[3] bone out	-----do-------	66	--------	Simmered	{ 3.0	--------	3.52	7¼	28½
					{ 2.0	--------	5.28	4¾	19
PORK, CURED (MILD)									
Bacon (24 slices per pound)	-----do-------	32	--------	Fried or broiled	2 slices	--------	12.00	2¼	8½
Canadian bacon	-----do-------	63	63	Broiled, sliced	{ 2	2.0	5.04	5	20
					{ 1	1.0	10.08	2½	10
Ham:									
Bone in	-----do-------	67	54	Roasted, slices and pieces	{ 4	2.9	2.68	9½	37½
					{ 3	2.2	3.57	7¼	28¼
	-----do-------	56	44	Roasted, slices	{ 4	2.4	2.24	11¼	44¾
					{ 3	1.8	2.99	8½	33½
Bone out	-----do-------	77	72	Roasted, slices and pieces	{ 4	2.9	3.08	8¼	32½
					{ 3	2.2	4.11	6¼	24½
	-----do-------	64	60	Roasted, slices	{ 4	2.4	2.56	10	39¼
					{ 3	1.8	3.41	7½	29½
Ground	-----do-------	77	77	Patties	{ 3	3.0	4.11	6¼	24½
					{ 2	2.0	6.16	4¼	16¼
Shoulder, Boston butt:									
Bone in	-----do-------	67	52	Roasted, bone out	{ 4	3.1	2.68	9½	37½
					{ 3	2.3	3.57	7¼	28¼
Bone out	-----do-------	74	58	Roasted	{ 4	3.1	2.96	8½	34
					{ 3	2.3	3.95	6½	25½
Shoulder, picnic:									
Bone in	-----do-------	56	41	Roasted, bone out	{ 4	3.9	2.24	11¼	44¾
					{ 3	2.2	2.99	8½	33½
Bone out	-----do-------	74	53	Roasted	{ 4	3.9	2.96	8½	34
					{ 3	2.2	3.95	6½	25½

See footnotes at end of table.

163-877—65—2

TABLE 1.—MEAT—Continued

Meat as purchased	Unit of purchase	Yield, cooked		Description of portion as served	Size of portion		Portions per purchase unit	Approximate purchase units for—	
		As served	Lean only		As served	Lean only		25 portions	100 portions
PORK, FRESH		*Percent*	*Percent*		*Ounces*	*Ounces*	*Number*	*Number*	*Number*
Chops:									
Loin	Pound	69	42	Broiled, bone in	5	3.0	2.21	11½	45¼
					3	1.8	3.68	7	27¼
Rib	do	70	37	do	5	2.6	2.24	11¼	44¾
					3	1.6	3.73	6¾	27
Cutlet, tenderloin	do	75	75	Broiled	3	3.0	4.00	6¼	25
					2	2.0	6.00	4¼	16¾
Ground pork	do	57	57	do	3	3.0	3.04	8¼	33
					2	2.0	4.56	5½	22
Liver	do	60	60	Pan- or oven-fried	3	3.0	3.20	8	31¼
					2	2.0	4.80	5¼	21
Roasts:									
Ham:									
Bone in	do	54	40	Roasted, bone out	4	3.0	2.16	11¾	46½
					3	2.2	2.88	8¾	34¾
Bone out	do	68	50	Roasted	4	3.0	2.72	9¼	37
					3	2.2	3.63	7	27¾
Loin:									
Bone in	do	68	37	Roasted, bone in	5	2.8	2.18	11½	46
					4	2.2	2.72	9¼	37
	do	47	37	Roasted, bone out	4	3.2	1.88	13½	53¼
					3	2.4	2.51	10	40
Bone out	do	68	54	Roasted	4	3.2	2.72	9¼	37
					3	2.4	3.63	7	27¾
Shoulder, Boston butt:									
Bone in	do	62	49	Roasted, bone out	4	3.2	2.48	10¼	40½
					3	2.4	3.31	7¾	30¼
Bone out	do	68	54	Roasted	4	3.2	2.72	9¼	37
					3	2.4	3.63	7	27¾
Shoulder, picnic:									
Bone in	do	47	35	Simmered, bone out	4	3.0	1.88	13½	53¼
					3	2.2	2.51	10	40
Bone out	do	64	47	Simmered	4	3.0	2.56	10	39¼
					3	2.2	3.41	7½	29½
Sausage:									
Brown and serve	do	81	81	Heated	3	3.0	4.32	6	23¼
					2	2.0	6.48	4	15½
Bulk or link	do	48	48	Oven-fried	3	3.0	2.56	10	39¼
					2	2.0	3.84	6¾	26¼
Spareribs	do	66	26	Braised, bone in	6	[4] 2.3	1.76	14¼	57
					4	[4] 1.6	2.64	9½	38
PORK, CANNED [5]									
Ham, chopped	do	100	100	Sliced	3	3.0	5.33	4¾	19
					2	2.0	8.00	3¼	12½

Ham, smoked	do	77	75	Slices and pieces	2	1.9	6.16	4¼	16¼
	do	73	71	Slices	3	2.9	3.89	6½	25¾
					2	1.9	5.84	4½	17¼
Pork luncheon meat (with natural juices).	do	89	89	Unheated	3	3.0	4.75	5½	21¼
					2	2.0	7.12	3¾	14¼
SAUSAGES									
Frankfurters:									
8 per pound	do	98	----	2 frankfurters	----	----	4.00	6¼	25
				1 frankfurter	----	----	8.00	3¼	12½
10 per pound	do	98	----	2 frankfurters	----	----	5.00	5	20
				1 frankfurter	----	----	10.00	2½	10
Luncheon meats (all meat varieties).	do	100	100		3	3.0	5.33	4¾	19
					2	2.0	8.00	3¼	12½
Vienna sausage (all meat)	Pound (drained weight).	100	100	About 4 sausages	2	2.0	8.00	3¼	12½
				About 2 sausages	1	1.0	16.00	1¾	6¼
VEAL, FRESH OR FROZEN									
Chops:									
Loin	Pound	78	47	Broiled, bone in	5	3.0	2.50	10	40
					3	1.8	4.16	6	24¼
Rib	do	69	38	do	5	2.8	2.21	11½	45¼
					3	1.6	3.68	7	27¼
Shoulder	do	66	40	do	5	3.0	2.11	12	47½
					3	1.8	3.52	7¼	28½
Cutlet, bone out	do	75	75	Broiled	4	3.0	3.00	8½	33½
					3	2.2	4.00	6¼	25
Ground	do	64	64	Oven- or pan-fried	3	3.0	3.41	7½	29½
					2	2.0	5.12	5	19¾
Heart	do	35	35	Braised	2	2.0	2.80	9	35¾
Liver, calf	do	58	58	Fried or braised	3	3.0	3.09	8¼	32½
					2	2.0	4.64	5½	21¾
Roasts:									
Chuck (shoulder):									
Bone in	do	46	40	Braised, bone out	4	3.4	1.84	13¾	54½
					3	2.6	2.45	10¼	41
Bone out	do	66	56	Braised	4	3.4	2.64	9½	38
					3	2.6	3.52	7¼	28½
Leg:									
Bone in	do	44	36	Roasted, bone out	4	3.3	1.76	14¼	57
					3	2.5	2.35	10¾	42¾
Bone out	do	66	54	Roasted	4	3.3	2.64	9½	38
					3	2.5	3.52	7¼	28½
Plate (breast):									
Bone in	do	45	33	Stewed, bone out	4	2.9	1.80	14	55¾
					3	2.2	2.40	10½	41¾
Bone out	do	66	48	Stewed	4	2.9	2.64	9½	38
					3	2.2	3.52	7¼	28½
Stew meat	do	66	48	do	4	2.9	2.64	9½	38
					3	2.2	3.52	7¼	28½

[1] Size of portion and number of portions per purchase unit are determined by use.

[2] For combination foods including beef, see p. 8.

[3] Breast, flank.

[4] Fat and lean.

[5] For combination foods including pork, see p. 8.

TABLE 2.—COMBINATION FOODS CONTAINING MEAT

Meat combinations, canned or frozen, as purchased	Unit of purchase	Weight per unit [1]	Cooked meat	Size of portion	Meat in portion	Portions per purchase unit	Approximate purchase units for—	
							25 portions	100 portions
		Pounds	*Percent*	*Ounces*	*Ounces*	*Number*	*Number*	*Number*
Beans with frankfurters in sauce	Pound	1.00	20	8	1.6	2.00	12½	50
	No. 3 cylinder	3.12	20	8	1.6	6.24	4¼	16¼
	No. 10 can	6.75	20	8	1.6	13.50	2	7½
Beans with ham in sauce	Pound	1.00	12	8	1.0	2.00	12½	50
	No. 3 cylinder	3.19	12	8	1.0	6.38	4	15¾
Beans with meat in chili sauce	Pound	1.00	8	8	.6	2.00	12½	50
	No. 10 can	6.50	8	8	.6	13.00	2	7¾
Beef goulash:								
Canned	Pound	1.00	18	8	1.4	2.00	12½	50
	No. 3 cylinder	3.12	18	8	1.4	6.24	4¼	16¼
Frozen	Carton	5.00	18	8	1.4	10.00	2½	10
	do	6.75	18	9	1.6	12.00	2¼	8½
	do	8.25	18	11	2.0	12.00	2¼	8½
Beef stew	Pound	1.00	18	8	1.4	2.00	12½	50
	No. 3 cylinder	3.12	18	8	1.4	6.24	4¼	16¼
	No. 10 can	6.62	18	8	1.4	13.24	2	7¾
Beef with barbecue sauce	Pound	1.00	50	6	3.0	2.67	9½	37½
	No. 3 cylinder	3.25	50	6	3.0	8.67	3	11¾
	No. 10 can	6.50	50	6	3.0	17.33	1½	6
Beef with gravy	Pound	1.00	50	6	3.0	2.67	9½	37½
	No. 3 cylinder	3.00	50	6	3.0	8.00	3¼	12¾
	No. 10 can	6.50	50	6	3.0	17.33	1½	6
Brunswick stew	Pound	1.00	18	8	1.4	2.00	12½	50
	No. 10 can	6.62	18	8	1.4	13.24	2	7¾
Chili con carne	Pound	1.00	28	8	2.2	2.00	12½	50
	No. 3 cylinder	3.19	28	8	2.2	6.38	4	15¾
	No. 10 can	6.75	28	8	2.2	13.50	2	7½
Chili con carne with beans	Pound	1.00	18	8	1.4	2.00	12½	50
	No. 3 cylinder	3.19	18	8	1.4	6.38	4	15¾
	No. 10 can	6.75	18	8	1.4	13.50	2	7½
Chili mac	Pound	1.00	18	8	1.4	2.00	12½	50
	No. 3 cylinder	3.19	18	8	1.4	6.38	4	15¾
	No. 10 can	6.50	18	8	1.4	13.00	2	7¾

Chop suey or chow mein vegetables with meat:								
Canned	Pound	1.00	8	8	.6	2.00	12½	50
	No. 3 cylinder	3.06	8	8	.6	6.12	4¼	16½
Frozen	Carton	5.00	8	8	.6	10.00	2½	10
Hash, corn beef, roast beef, beef	Pound	1.00	35	7	2.4	2.29	11¼	44¼
	No. 3 cylinder	3.19	35	7	2.4	7.29	3½	14
	No. 10 can	6.50	35	7	2.4	14.86	1¾	7
Lamb stew	Pound	1.00	18	8	1.4	2.00	12½	50
	No. 3 cylinder	3.19	18	8	1.4	6.38	4	15¾
	No. 10 can	6.62	18	8	1.4	13.24	2	7¾
Macaroni and beef in tomato sauce	Pound	1.00	8	8	.6	2.00	12½	50
	No. 10 can	6.50	8	8	.6	13.00	2	7¾
Meatballs with gravy:								
Canned	Pound	1.00 (10 count)	38	6	2.3 (4 count)	2.67	9½	37½
	No. 10 can	6.50 (70 count)	38	6	2.3 (4 count)	17.33	1½	6
Frozen	Carton	8.00 (160 count)	38	6	2.3 (7½ count)	21.33	1¼	5
	do	10.00 (100 count)	38	6	2.3 (4 count)	26.67	1	4
Pork with barbecue sauce:								
Canned	Pound	1.00	50	6	3.0	2.67	9½	37½
	No. 3 cylinder	3.19	50	6	3.0	8.51	3	12
	No. 10 can	6.62	50	6	3.0	17.65	1½	5¾
In waxed tub (perishable)	4-pound tub	4.00	50	6	3.0	10.67	2½	9½
	5-pound tub	5.00	50	6	3.0	13.33	2	7¾
Pork with gravy	Pound	1.00	50	6	3.0	2.67	9½	37½
	No. 3 cylinder	3.12	50	6	3.0	8.32	3¼	12¼
	No. 10 can	6.50	50	6	3.0	17.33	1½	6
Ravioli with meat in sauce	Pound	1.00	7	8	.6	2.00	12½	50
	No. 3 cylinder	3.19	7	8	.6	6.38	4	15¾
		3.62	7	8	.6	7.24	3½	14
Spaghetti with meatballs and sauce	Pound	1.00	8	8	.6	2.00	12½	50
	No. 3 cylinder	3.19	8	8	.6	6.38	4	15¾
	No. 10 can	6.62	8	8	.6	13.24	2	7¾
Tamales, frozen	Pound	1.00 (4 tamales)	18	8 (2 tamales)	1.4	2.00	12½	50
	Carton	6.00 (24 tamales)	18	8 (2 tamales)	1.4	12.00	2¼	8½
	do	18.00	18	8	1.4	36.00	(2)	3
Tamales with gravy or sauce (Packed in sizes from 1½ oz. to 6 oz. per tamale).	Pound	1.00	14	8	1.1	2.00	12½	50
	No. 10 can	6.50	14	8	1.1	13.00	2	7¾

[1] Net weights of containers are not standardized and may vary depending on establishment preparing the product.
[2] Number of purchase units needed is less than one.

TABLE 3.—POULTRY

Poultry as purchased	Unit of purchase	Yield, as served	Description of portion as served	Size of portion		Portions per purchase unit	Approximate purchase units for—	
				As served	Edible portion [1]		25 portions	100 portions
CHICKEN, FRESH OR FROZEN								
Live:		*Percent*		*Ounces*	*Ounces*	*Number*	*Number*	*Number*
Roasters	Pound	30	Boned, excludes neck and giblets.	3.0	3.0	1.60	15¾	62½
				2.0	2.0	2.40	10½	41¾
Stewers	do	34	Boned, includes neck and giblets.	3.0	3.0	1.81	14	55¼
				2.0	2.0	2.72	9¼	37
Ready-to-cook:								
Broilers	1½-pound bird	70	½ bird	8.3	5.4	2.00	12½	50
Fryers	Pound [2]	43	Boned	3.0	3.0	2.29	11	43¾
				2.0	2.0	3.44	7½	29¼
	2½-pound bird	65	¼ bird	5.8	3.9	4.00	6¼	25
			⅙ bird	3.9	2.6	6.00	4¼	16¾
			⅛ bird	2.9	1.9	8.00	3¼	12½
Parts (from 2½-pound bird):								
Breast half	Pound	67	With bone	3.2	2.6	3.35	7½	30
Drumstick	do	72	do	2.1	1.4	5.49	4¾	18¼
Thigh	do	68	do	2.2	1.6	4.95	5¼	20¼
Drumstick and thigh	do	70	do	4.3	3.1	2.60	9¾	38½
Wing	do	64	do	1.6	0.8	6.40	4	15¾
Back	do	49	do	2.5	1.3	3.14	8	32
Rib	do	65	do	2.5	1.3	4.16	6¼	24¼
Giblets:								
Gizzards	do	26		2	2	2.08	12¼	48¼
Hearts	do	38		2	2	3.04	8¼	33
Livers	do	65		2	2	5.20	5	19¼
Roasters	do	42	Boned, excludes neck and giblets.	3	3	2.24	11¼	44¾
				2	2	3.36	7½	30
Stewers	do	47	Boned, includes neck and giblets.	3	3	2.51	10	40
				2	2	3.76	6¾	26¾
CHICKEN, CANNED								
Boned	do	90	Meat	3	3	4.80	5¼	21
				2	2	7.20	3½	14
	Can (35 ounces)	90	do	3	3	10.50	2½	9¾
				2	2	15.75	1¾	6½
Boned, solid pack	Pound	95	do	3	3	5.07	5	19¾
				2	2	7.60	3¼	13¼

Boned, with broth	do	80	do	2	2	6. 40	4	15¾
Whole	do	32	do	3	3	1. 71	14¾	58½
				2	2	2. 56	10	39¼
TURKEY, FRESH OR FROZEN								
Live	do	36	Excludes neck and giblets	3	3	1. 92	13¼	52¼
				2	2	2. 88	8¾	34¾
Ready-to-cook:								
Roasters	do	47	do	3	3	2. 51	10	40
				2	2	3. 76	6¾	26¾
Parts:								
Breasts, whole	do	60		3	3	3. 20	8	31¼
				2	2	4. 80	5¼	21
Legs (thigh and drumstick)	do	48		3	3	2. 56	10	39¼
				2	2	3. 84	6¾	26¼
Giblets:								
Gizzards	do	34		2	2	2. 72	9¼	37
Hearts	do	38		2	2	3. 04	8¼	33
Livers	do	67		2	2	5. 36	4¾	18¾
TURKEY, FROZEN ONLY								
Stuffed, whole	do	33	Boned meat	3	3	1. 76	14¼	57
				2	2	2. 64	9½	38
Rolls, precooked	do	92	Meat	3	3	4. 91	5¼	20½
				2	2	7. 36	3½	13¾
Rolls, ready-to-cook	do	61	do	3	3	3. 25	7¾	31
				2	2	4. 88	5¼	20½
TURKEY, CANNED								
Boned	do	90	do	3	3	4. 80	5¼	21
				2	2	7. 20	3½	14
	Can (35 ounces)	90	do	3	3	10. 50	2½	9¾
				2	2	15. 75	1¾	6½
Boned, solid pack	Pound	95	do	3	3	5. 07	5	19¾
				2	2	7. 60	3½	13¼
Boned, with broth	do	80	do	3	3	4. 27	6	23½
				2	2	6. 40	4	15¾
OTHER POULTRY, FRESH OR FROZEN								
Duck, ready-to-cook	do	38	Boned, excludes neck and giblets.	3	3	2. 03	12½	49½
				2	2	3. 04	8¼	33
Goose, ready-to-cook	do	39	do	3	3	2. 08	12¼	48¼
				2	2	3. 12	8¼	32¼

[1] Includes edible skin.

[2] Based on 2½-pound bird as purchased; neck and giblets not served.

TABLE 4.—COMBINATION FOODS CONTAINING POULTRY

Poultry combinations, canned or frozen, as purchased	Unit of purchase [1]	Weight per unit	Cooked meat	Size of portion	Meat in portion	Portions per purchase unit	Approximate purchase units for—	
							25 portions	100 portions
		Pounds	*Percent*	*Ounces*	*Ounces*	*Number*	*Number*	*Number*
Chicken a la king	Pound	1.00	20	8	1.60	2.00	12½	50
Chickenburgers	do	1.00	100	3	3.00	5.33	4¾	19
Chicken cacciatore	do	1.00	20	8	1.60	2.00	12½	50
Chicken chop suey	do	1.00	4	8	.32	2.00	12½	50
Chicken chow mein	do	1.00	4	8	.32	2.00	12½	50
Chicken fricassee	do	1.00	20	8	1.60	2.00	12½	50
Chicken noodles or dumplings	do	1.00	15	8	1.20	2.00	12½	50
Chicken potpie	do	1.00	14	8	1.12	2.00	12½	50
Chicken stew	do	1.00	12	8	.96	2.00	12½	50
Chicken tamales	do	1.00	6	8	.48	2.00	12½	50
Creamed chicken	do	1.00	20	8	1.60	2.00	12½	50
Creamed turkey	do	1.00	20	8	1.60	2.00	12½	50
Minced chicken barbecue	do	1.00	40	3	1.20	5.33	4¾	19
Noodles or dumplings with chicken	do	1.00	6	8	.48	2.00	12½	50
Sliced chicken with gravy	do	1.00	35	6	2.10	2.67	9½	37½
Sliced turkey with gravy	do	1.00	35	6	2.10	2.67	9½	37½
Turkey a la king	do	1.00	20	8	1.60	2.00	12½	50
Turkey fricassee	do	1.00	20	8	1.60	2.00	12½	50
Turkey potpie	do	1.00	14	8	1.12	2.00	12½	50

[1] There is no standardization of can or carton sizes for canned and frozen poultry products. Information given for a pound may be related to the weight of the contents of the can or carton.

Fish and shellfish as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
FISH, CANNED		*Pounds*	*Percent*		*Number*	*Number*	*Number*
Gefiltefish	16-ounce can (9¼ ounces drained).	1.00	58	3 ounces drained	3.08	8¼	32½
				2 ounces drained	4.62	5½	21¾
	32-ounce can (20½ ounces drained).	2.00	64	3 ounces drained	6.83	3¾	14¾
				2 ounces drained	10.25	2½	10
	51-ounce can (39 ounces drained).	3.19	76	3 ounces drained	13.00	2	7¾
				2 ounces drained	19.50	1½	5¼
Mackerel	15-ounce can (12½ ounces drained).	.94	83	3 ounces drained	4.17	6	24
				2 ounces drained	6.25	4	16
Salmon	3¾-ounce can (2¼ ounces drained).	.23	60	2¼ ounces drained	1.00	25	100
	16-ounce can (13 ounces drained).	1.00	81	3 ounces drained	4.33	6	23¼
				2 ounces drained	6.50	4	15½
	64-ounce can (50 ounces drained).	4.00	78	3 ounces drained	16.67	1½	6
				2 ounces drained	25.00	1	4
Sardines:							
Maine	3¾- to 4-ounce can (3¾ ounces drained).	.23 to .25	100	3 ounces drained	1.25	20	80
				2 ounces drained	1.87	13½	53½
	12-ounce can (10¼ ounces drained).	.75	90	3 ounces drained	3.58	7	28
				2 ounces drained	5.38	4¾	18¾
Pacific:							
In brine	15-ounce can (11½ ounces drained).	.94	77	3 ounces drained	3.83	6¾	26¼
				2 ounces drained	5.75	4½	17½
In mustard or tomato sauce	15-ounce can	.94	100	3 ounces	5.00	5	20
				2 ounces	7.50	3½	13½
Tuna	3½- to 4-ounce can (3¼ ounces drained).	.22 to .25	93	3¼ ounces drained	1.00	25	100
	6- to 7-ounce can (6 ounces drained).	.38 to .44	100	3 ounces drained	2.00	12½	50
				2 ounces drained	3.00	8½	33½
	60- to 66½-ounce can (58 ounces drained).	3.75 to 4.16	97	3 ounces drained	19.33	1½	5¼
				2 ounces drained	29.00	(1)	3½
FISH, DRIED							
Salt cod	Pound	1.00	72	3 ounces	3.84	6¾	26¼
				2 ounces	5.76	4½	17½
FISH, FRESH OR FROZEN							
Fillets	do	1.00	64	3 ounces	3.41	7½	29½
				2 ounces	5.12	5	19¾
Steaks (backbone in)	do	1.00	[2] 58	3 ounces	3.09	8¼	32½
				2 ounces	4.64	5½	21¾
Dressed (scaled and eviscerated, usually head, tail, and fins removed).	do	1.00	[2] 45	3 ounces	2.40	10½	41¾
				2 ounces	3.60	7	28
Drawn (entrails removed)	do	1.00	[2] 32	3 ounces	1.71	14¾	58½
				2 ounces	2.56	10	39¼
Whole, or round (as caught)	do	1.00	[2] 27	3 ounces	1.44	17½	69½
				2 ounces	2.16	11¾	46½

See footnotes at end of table.

TABLE 5.—FISH AND SHELLFISH—Continued

Fish and shellfish as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
FISH, FROZEN							
Portions:							
Breaded, fried or raw:		*Pounds*	*Percent*		*Number*	*Number*	*Number*
5⅓-ounce	Pound	1.00	95	1 portion	3.00	8½	33½
4-ounce	do	1.00	95	do	4.00	6¼	25
3-ounce	do	1.00	95	do	5.33	4¾	18¾
2-ounce	do	1.00	95	do	8.00	3¼	12½
Unbreaded:							
4-ounce	do	1.00	69	do	4.00	6¼	25
3-ounce	do	1.00	69	do	5.33	4¾	18¾
2-ounce	do	1.00	68	do	8.00	3¼	12½
Sticks, breaded, fried or raw, 1-ounce	do	1.00	85	4 sticks	4.00	6¼	25
				3 sticks	5.33	4¾	18¾
				2 sticks	8.00	3¼	12½
SHELLFISH, CANNED							
Clam chowder	8-ounce can, ready-to-serve.	.50	100	8 ounces	1.00	25	100
	10½-ounce can, condensed.	.66	200	do	2.62	9¾	38¼
	15-ounce can, condensed	.94	200	do	3.75	6¾	26¾
	50- to 51-ounce can, condensed.	3.12 to 3.19	200	do	12.50	2	8
Clam juice	8-fluid-ounce can		100	3 fluid ounces	2.67	9½	37½
	12-fluid-ounce can		100	do	4.00	6¼	25
Clams, minced	7½-ounce can	.47	100	3 ounces	2.50	10	40
				2 ounces	3.75	6¾	26¾
	51-ounce can	3.19	100	3 ounces	17.00	1½	6
				2 ounces	25.50	1	4
Crabmeat	6½-ounce can (5½ ounces drained).	.41	85	3 ounces drained	1.83	13¾	54¾
				2 ounces drained	2.75	9¼	36½
Oysters, whole	5-ounce can (5 ounces drained).	.31	100	3 ounces drained	1.67	15	60
				2 ounces drained	2.50	10	40
Oyster stew	10½-ounce can, ready-to-serve.	.66	100	8 ounces	1.31	19¼	76½
Shrimp	4½-ounce can (4½ ounces drained).	.28	100	3 ounces drained	1.50	16¾	66¾
				2 ounces drained	2.25	11¼	44½
SHELLFISH, FRESH, LIVE IN SHELL							
Clams:							
Hard	Dozen		[2] 14	6 clams on half shell	2.00	12½	50
Soft	do		[2] 29	12 clams in the shell	1.00	25	100
Crabs:							
Blue	Pound	1.00	14	3 ounces cooked	.75	33½	133½
				2 ounces cooked	1.12	22½	89½
Dungeness	do	1.00	24	3 ounces cooked	1.28	19¾	78¼
				2 ounces cooked	1.92	13¼	52¼

Oysters, [illegible]	[illegible]	[illegible]	12	6 oysters or half shell	2. 56	12½	50
SHELLFISH, FRESH OR FROZEN							
Clams, shucked	Pound	1. 00	48	3 ounces meat	2. 56	10	39¼
				2 ounces meat	3. 82	6¾	26
Crabs, cooked in shell:							
Blue	do	1. 00	14	3 ounces meat	. 75	33½	133½
				2 ounces meat	1. 12	22½	89½
Dungeness	do	1. 00	24	3 ounces meat	1. 28	19¾	78¼
				2 ounces meat	1. 92	13¼	52¼
Crabmeat	do	1. 00	97	3 ounces	5. 17	5	19½
				2 ounces	7. 76	3¼	13
Lobster, cooked in shell	do	1. 00	[2] 25	1 lobster	1. 00	25	100
				½ lobster	2. 00	12½	50
Lobster meat	do	1. 00	91	3 ounces	4. 85	5¼	20¾
				2 ounces	7. 28	3½	13¾
Oysters, shucked	do	1. 00	40	3 ounces	2. 13	11¾	47
				2 ounces	3. 20	8	31¼
Scallops, shucked	do	1. 00	63	3 ounces	3. 36	7½	30
				2 ounces	5. 04	5	20
Shrimp:							
Cooked, peeled, cleaned	do	1. 00	100	3 ounces	5. 33	4¾	19
				2 ounces	8. 00	3¼	12½
Raw, in shell	do	1. 00	50	3 ounces meat	2. 67	9½	37½
				2 ounces meat	4. 00	6¼	25
Raw, peeled	do	1. 00	62	3 ounces meat	3. 30	7¾	30½
				2 ounces meat	4. 96	5¼	20¼
SHELLFISH, FROZEN							
Clams, breaded:							
Fried	do	1. 00	85	3 ounces	4. 53	5¾	22¼
				2 ounces	6. 80	3¾	14¾
Raw	do	1. 00	83	3 ounces	4. 43	5¾	22¾
				2 ounces	6. 64	4	15¼
Crabcakes, fried	do	1. 00	95	3 ounces	5. 07	5	19¾
				2 ounces	7. 60	3½	13¼
Lobster, spiny tails:							
8 ounce	do	1. 00	[2] 51	1 tail	2. 00	12½	50
6 ounce	do	1. 00	[2] 51	do	2. 67	9½	37½
4 ounce	do	1. 00	[2] 51	do	4. 00	6¼	25
Oysters, breaded, raw	do	1. 00	88	3 ounces	4. 69	5½	21½
				2 ounces	7. 04	3¾	14¼
Scallops, breaded:							
Fried	do	1. 00	93	3 ounces	4. 96	5¼	20¼
				2 ounces	7. 44	3½	13½
Raw	do	1. 00	81	3 ounces	4. 32	6	23¼
				2 ounces	6. 48	4	15½
Shrimp, breaded:							
Fried	do	1. 00	88	3 ounces	4. 69	5½	21½
				2 ounces	7. 04	3¾	14¼
Raw	do	1. 00	85	3 ounces	4. 53	5¾	22¼
				2 ounces	6. 80	3¾	14¾

[1] Number of purchase units needed is less than one.

[2] Yield, edible portion.

TABLE 6.—EGGS

Eggs, in shell, frozen, and dried, as purchased	Unit of purchase	Weight per unit	Portion as served or used	Portions per purchase unit	Approximate purchase units for—	
					25 portions	100 portions
In shell:		*Pounds*		*Number*	*Number*	*Number*
Large	Dozen	1. 50	1 egg	12. 00	2¼	8½
	Case	45. 00	do	360. 00	(1)	(1)
Medium	Dozen	1. 31	do	12. 00	2¼	8½
	Case	39. 50	do	360. 00	(1)	(1)
Small	Dozen	1. 12	do	12. 00	2¼	8½
	Case	34. 00	do	360. 00	(1)	(1)
Frozen:						
Whole eggs	Pound	1. 00	1 egg (3 tablespoons thawed)	10. 00	(2)	(2)
			12 eggs (2¼ cups thawed)	. 83	(2)	(2)
	Can	10. 00	1 egg	100. 00	(2)	(2)
	do	30. 00	do	300. 00	(2)	(2)
Egg yolks	Pound	1. 00	1 yolk (1⅓ tablespoons thawed)	26. 00	(2)	(2)
			12 yolks (1 cup thawed)	2. 16	(2)	(2)
Egg whites	do	1. 00	1 white (2 tablespoons thawed)	16. 00	(2)	(2)
			12 whites (1½ cups thawed)	1. 33	(2)	(2)
Dried:						
Whole eggs	do	1. 00	1 large egg (½ ounce or 2½ tablespoons dried + 2½ tablespoons water).	32. 00	(2)	(2)
			12 large eggs (6 ounces or 2 cups dried + 2 cups water).	2. 67	(2)	(2)
	13-ounce package	. 81	1 large egg	26. 00	(2)	(2)
	No. 10 can	3. 00	do	96. 00	(2)	(2)
	Package	25. 00	do	800. 00	(2)	(2)
	do	50. 00	do	1, 600. 00	(2)	(2)
Egg yolks	Pound	1. 00	1 large yolk (2 tablespoons dried + 2 teaspoons water).	54. 00	(2)	(2)
			12 large yolks (1½ cups dried + ½ cup water)	4. 50	(2)	(2)
	Package	3. 00	1 large yolk	162. 00	(2)	(2)
Egg white, spray-dried	Pound	1. 00	1 large white (2 teaspoons dried + 2 tablespoons water).	100. 00	(2)	(2)
			12 large whites (½ cup dried + 1½ cups water)	8. 33	(2)	(2)
	Package	3. 00	1 large white	300. 00	(2)	(2)

[1] Number of purchase units needed is less than one.

[2] Number of purchase units needed is determined by use.

TABLE 7.—NUTS

Nuts in shell and peanut butter as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as used	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Almonds;							
Nonpareil (softshell)	Pound	1. 00	60	1 cup (0.31 pound)	1. 94	(1)	(1)
Peerless (hardshell)	do	1. 00	35	do	1. 13	(1)	(1)
Brazil nuts	do	1. 00	48	do	1. 55	(1)	(1)
Cashew nuts	do	1. 00	22	1 cup (0.30 pound)	. 73	(1)	(1)
Chestnuts	do	1. 00	84	8 large nuts (0.11 pound)	7. 64	(1)	(1)
Coconut:							
Dried	do	1. 00	100	1 cup (0.14 pound)	7. 14	(1)	(1)
Fresh, in shell	do	1. 00	52	1 cup (0.21 pound)	2. 48	(1)	(1)
Filberts	do	1. 00	39	1 cup (0.30 pound)	1. 50	(1)	(1)
Peanuts, roasted	do	1. 00	68	1 cup (0.32 pound)	2. 12	(1)	(1)
Peanut butter	do	1. 00	100	2 tablespoons (0.07 pound)	14. 29	1¾	7
	No. 10 can	6. 75	100	do	96. 43	(2)	1¼
Pecans	Pound	1. 00	52	1 cup halves (0.24 pound)	2. 17	(1)	(1)
Walnuts:							
Black	do	1. 00	22	1 cup (0.28 pound)	. 79	(1)	(1)
English	do	1. 00	45	1 cup (0.22 pound)	2. 05	(1)	(1)

[1] Number of purchase units needed is determined by use.

[2] Number of purchase units needed is less than one.

TABLE 8.—DAIRY PRODUCTS

Dairy products as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served or used	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Cheese:							
Cheddar	Pound	1.00	100	4 ounces, grated, 1 cup	4.00	6¼	25
	do	1.00	100	2 ounces	8.00	3¼	12½
	do	1.00	100	1 ounce	16.00	1¾	6¼
	Longhorn	11 to 13	100	2 ounces	88–104	(1)	1¼
	Daisies	20 to 25	100	do	160–200	(1)	(1)
	Flats	32 to 37	100	do	256–296	(1)	(1)
	Cheddars	70 to 78	100	do	560–624	(1)	(1)
	Block	20	100	do	160.00	(1)	(1)
	do	40	100	do	320.00	(1)	(1)
Cottage, small or large curd, with pineapple or chive.	Pound	1.00	100	4 ounces	4.00	6¼	25
				2 ounces	8.00	3¼	12½
	32-ounce carton	2.00	100	4 ounces	8.00	3¼	12½
	Tin	30.00	100	do	120.00	(1)	(1)
Cream	8-ounce package	.50	100	1 ounce	8.00	3¼	12½
	12-ounce package	.75	100	do	12.00	2¼	8½
	16-ounce package	1.00	100	do	16.00	1¾	6¼
Processed, cheese food	Pound	1.00	100	2 ounces	8.00	3¼	12½
				1 ounce, 1 slice	16.00	1¾	6¼
	Package	2.00	100	2 ounces	16.00	1¾	6¼
	do	5.00	100	do	40.00	(1)	2½
Cream:							
Half and half	Pint	1.07	100	1½ tablespoons	21.33	1¼	4¾
	Quart	2.14	100	do	42.67	(1)	2½
Light	Pint	1.06	100	do	21.33	1¼	4¾
	Quart	2.13	100	do	42.67	(1)	2½
Sour	½ pint	.53	100	1 tablespoon	16.00	1¾	6¼
	¾ pint	.80	100	do	24.00	1¼	4¼
Whipping (volume doubles when whipped).	Pint	1.05	100	1¼ tablespoons	25.60	1	4
	Quart	2.10	100	do	51.20	(1)	2

Brick	Quart	1.25	100	1 slice (½ cup)	8.00	3¾	12½
Bulk	Gallon	4.50	100	No. 12 scoop (sundae)	22–26	1	4
				No. 16 scoop	31–35	(1)	3
				No. 20 scoop (a la mode)	38–42	(1)	2½
				No. 24 scoop	47–51	(1)	2
Cups	3-ounce	.19	100	1 cup	1.00	25	100
	5-ounce	.31	100	do	1.00	25	100
Sherbet	Gallon	6.00	100	No. 12 scoop	25.00	1	4
				No. 16 scoop	35.00	(1)	3
				No. 20 scoop	42.00	(1)	2½
				No. 24 scoop	50.00	(1)	2
Milk:							
Fluid [2]	Quart	2.15	100	1 cup	4.00	6¼	25
	Gallon	8.60	100	do	16.00	1¾	6¼
	5-gallon	43.00	100	do	80.00	(1)	1¼
Condensed	14-ounce can	.88	100	do	1.24	(3)	(3)
	15-ounce can	.94	100	do	1.33	(3)	(3)
Evaporated	14½-ounce can	.91	100	1 cup as is	1.67	(3)	(3)
		.91	200	1 cup reconstituted	3.33	(3)	(3)
	No. 10 can	8.00	100	1 cup as is	14.00	(3)	(3)
		8.00	200 (measure)	1 cup reconstituted	28.00	(3)	(3)
Dry:							
Nonfat:							
Instant	Pound (about 6½ cups)	1.00	100	1 cup as is	6.50	(3)	(3)
		1.00	267 (measure)	1 cup reconstituted	17.06	(3)	(3)
Regular (USDA)	Pound (about 3¼ cups)	1.00	100	1 cup as is	3.25	(3)	(3)
		1.00	533 (measure)	1 cup reconstituted	17.06	(3)	(3)
Whole	Pound (about 3½ cups)	1.00	100	1 cup as is	3.50	(3)	(3)
		1.00	400 (measure)	1 cup reconstituted	14.22	(3)	(3)

[1] Number of purchase units needed is less than one.
[2] Skim milk and buttermilk weigh slightly more than whole fluid milk.
[3] Number of purchase units needed is determined by use.

TABLE 9.—VEGETABLES—FRESH

Fresh vegetables as purchased	Unit of purchase	Weight per unit [1]	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Asparagus	Pound	1.00		4 medium spears, cooked	3.38	7½	29¾
	do	1.00	49	3 ounces cut spears, cooked	2.61	9¾	38½
	Crate	28.00	49	do	73.17	(2)	1½
Beans, lima, green:							
In pod	Pound	1.00	40	3 ounces cooked	2.13	11¾	47
	Bushel	32.00	40	do	68.27	(2)	1½
Shelled	Pound	1.00	102	do	5.44	4¾	18½
Beans, snap, green or wax	do	1.00	84	do	4.48	5¾	22½
	Bushel	30.00	84	do	134.40	(2)	(2)
Beet greens, untrimmed	Pound	1.00	44	do	2.35	10¾	42¾
	Bushel	20.00	44	do	46.93	(2)	2¼
Beets:							
With tops	Pound	1.00	43	3 ounces sliced or diced, cooked	2.29	11	43¾
Without tops	do	1.00	76	do	4.05	6¼	24¾
	Burlap bag	50.00	76	do	202.67	(2)	(2)
Blackeye peas, shelled	Pound	1.00	93	3 ounces cooked	4.96	5¼	20¼
Broccoli	do	1.00		2 medium spears, cooked	4.57	5½	22
	do	1.00	62	3 ounces cut spears, cooked	3.31	7¾	30¼
	Crate	40.00	62	do	132.27	(2)	(2)
Brussels sprouts	Pound	1.00	77	3 ounces cooked	4.11	6¼	24½
Cabbage	Bulk	1.00	79	2 ounces coleslaw	6.32	4	16
	do	1.00	75	3 ounces sliced, cooked	4.00	6¼	25
	do	1.00	80	3-ounce wedge, cooked	4.27	6	23½
	Crate or sack	50.00	80	do	213.33	(2)	(2)
Cabbage, Chinese	Pound	1.00	88	2 ounces raw	7.04	3¾	14¼
Carrots, without tops	do	1.00	82	2 ounces shredded or grated, strips or diced, raw.	6.56	4	15¼
	do	1.00	75	3 ounces sliced or diced, cooked	4.00	6¼	25
	Bushel	50.00	75	do	200.00	(2)	(2)
Cauliflower	Pound	1.00	45	2 ounces sliced, raw	3.60	7	28
	do	1.00	44	3 ounces cooked	2.35	10¾	42¾
	Crate	37.00	44	do	86.83	(2)	1¼
	Crate, large	50.00	44	do	117.33	(2)	(2)
Celery	Pound	1.00	70	3 ounces chopped, cooked	3.73	6¾	27
	do	1.00	75	3 ounces sliced, raw	4.00	6¼	25
	do	1.00	75	2 ounces strips, raw	6.00	4¼	16¾
	Crate	60.00	75	3 ounces chopped, raw	240.00	(2)	(2)
Celery hearts (24 pack)	Crate or box	30.00	95	2 ounces strips, raw	228.00	(2)	(2)
Chard, untrimmed	Pound	1.00	56	3 ounces	2.99	8½	33½
Collards	do	1.00	81	3 ounces cooked	4.32	6	23¼
	Bushel	20.00	81	do	86.40	(2)	1¼
Corn, in husks	Dozen	8.00	37	3 ounces cooked kernels	15.79	1¾	6½
	do	8.00		1 ear, cooked	12.00	2¼	8½
	5-dozen crate or bag.	40.00		do	60.00	(2)	1¾

	do	1.00	95	3 ounces sliced, unpeeled, raw	5.07	5	19¾
	Bushel	48.00	95	do	243.20	(2)	(2)
Eggplant	Pound	1.00	75	4 ounces cooked	3.00	8½	33½
	Bushel	33.00	75	do	100.00	(2)	1
Endive, escarole, chicory	Pound	1.00	75	1 ounce raw	12.00	2¼	8½
	Bushel	25.00	75	do	300.00	(2)	(2)
Kale, untrimmed	Pound	1.00	81	3 ounces cooked	4.32	6	23¼
	Bushel	18.00	81	do	77.76	(2)	1½
Kohlrabi	Pound	1.00	50	do	2.67	9½	37½
Lettuce:							
Head	do	1.00	74	2 ounces raw	5.92	4¼	17
Iceberg	Carton	2 doz. heads	----------	⅙ head, raw	144.00	4¼ heads	17 heads
Romaine	Pound	1.00	64	1 ounce raw	10.24	2½	10
Mushrooms	do	1.00	67	1 ounce sliced, cooked	10.72	2½	9½
	Basket	3.00	67	3 ounces sliced, cooked	10.72	2½	9½
	do	9.00	67	do	32.16	(2)	3¼
Mustard greens	Pound	1.00	59	3 ounces cooked	3.15	8	31¾
	Bushel	20.00	59	do	62.93	(2)	1¾
Okra	Pound	1.00	96	do	5.12	5	19¾
	Bushel	30.00	96	do	153.60	(2)	(2)
Onions:							
Green, partly topped	Pound	1.00	60	3 ounces raw	3.20	8	31¼
	Wirebound crate	50.00	60	do	160.00	(2)	(2)
Mature	Pound	1.00	89	1 ounce chopped or grated, raw	14.24	2	7¼
	do	1.00	76	3 ounces small whole or pieces, cooked.	4.05	6¼	24¾
	Sack	50.00	76	do	202.67	(2)	(2)
Parsley	Pound	1.00	----------	½ cup	16.00	(3)	(3)
	Crate	19.00	----------	do	304.00	(3)	(3)
Parsnips	Pound	1.00	84	3 ounces cooked	4.48	5¾	22½
	Bushel	50.00	84	do	224.00	(2)	(2)
Peas, green:							
In pod	Pound	1.00	36	do	1.92	13¼	52¼
	Basket	15.00	36	do	28.80	(2)	3½
	Bushel	28.00	36	do	53.76	(2)	2
Shelled	Pound	1.00	96	do	5.12	5	19¾
Peppers, green	do	1.00	82	1 ounce diced or strips, raw	13.12	2	7¾
	Bushel	25.00	82	do	328.00	(2)	(2)
	Carton	30.00	82	do	393.60	(2)	(2)
	Pound	1.00	75	2 ounces strips, cooked	6.00	4¼	16¾
Potatoes:							
To be pared by hand	do	1.00	----------	1 medium, boiled	3.00	8½	33½
	do	1.00	54	2 ounces french fried	4.32	6	23¼
	do	1.00	80	3 ounces cubed and diced, cooked	4.27	6	23½
	do	1.00	95	4 ounces mashed	3.80	6¾	26½
To be pared by machine	do	1.00	----------	1 medium, boiled	3.00	8½	33½
	do	1.00	52	2 ounces french fried	4.16	6¼	24¼
	do	1.00	76	3 ounces cubed and diced, cooked	4.05	6¼	24¾
	do	1.00	90	4 ounces mashed	3.60	7	28
Ready-to-cook	do	1.00	----------	1 medium, boiled	3.00	8½	33½
	do	1.00	68	2 ounces french fried	5.44	4¾	18½
	do	1.00	119	4 ounces mashed	4.76	5¼	21¼
To be cooked in jacket	do	1.00	----------	1 medium, baked in jacket	3.00	8½	33½
	do	1.00	----------	1 medium, boiled	3.00	8½	33½
	do	1.00	87	3 ounces cubed and diced	4.64	5½	21¾
	do	1.00	104	4 ounces mashed	4.16	6¼	24¼

See footnotes at end of table.

TABLE 9.—VEGETABLES—FRESH—Continued

Fresh vegetables as purchased	Unit of purchase	Weight per unit [1]	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Pumpkin	Pound	1.00	63	4 ounces mashed, cooked	2.52	10	39¾
Radishes:							
With tops	do	1.00	63	1 ounce sliced, raw	10.08	2½	10
	do	1.00	----------	4 small	11.34	2¼	9
Without tops	do	1.00	90	1 ounce sliced, raw	14.40	1¾	7
Rutabagas	do	1.00	79	3 ounces cubed, cooked	4.21	6	24
	do	1.00	77	4 ounces mashed	3.08	8¼	32½
	Bushel	56.00	77	do	172.48	(2)	(2)
Spinach:							
Partly trimmed	Pound	1.00	92	1 ounce raw for salad	14.72	1¾	7
Untrimmed	do	1.00	72	do	11.52	2¼	8¾
	do	1.00	67	3 ounces cooked	3.57	7¼	28¼
	Bushel	20.00	67	do	71.47	(2)	1½
Squash, summer	Pound	1.00	83	3 ounces diced or sliced, cooked	4.43	5¾	22¾
	Bushel	35.00	83	do	154.93	(2)	(2)
	Pound	1.00	83	4 ounces mashed	3.32	7¾	30¼
Squash, winter:							
Acorn	do	1.00	----------	½ medium, baked	2.00	12½	50
Hubbard	do	1.00	58	4 ounces cubed, cooked	2.32	11	43¼
	do	1.00	57	4 ounces mashed	2.28	11	44
Sweetpotatoes	do	1.00	----------	1 medium, cooked in jacket	2.00	12½	50
	do	1.00	83	3 ounces sliced	4.43	5¾	22¾
	do	1.00	81	4 ounces mashed	3.24	7¾	31
	Bushel	50.00	----------	1 medium, cooked in jacket	100.00	(2)	1
Tomatoes (medium)	Pound	1.00	91	2 slices	7.50	3½	13½
	do	1.00	----------	1 wedge	12.00	2¼	8½
	Lug	32.00	----------	do	384.00	(2)	(2)
	Bushel	53.00	----------	do	636.00	(2)	(2)
Turnip greens, untrimmed	Pound	1.00	48	3 ounces cooked	2.56	10	39¼
	Bushel	20.00	48	do	51.20	(2)	(2)
Turnips, without tops	Pound	1.00	74	3 ounces cubed, cooked	3.95	6½	25½
	do	1.00	73	4 ounces mashed	2.92	8¾	34¼
	Bushel	50.00	73	do	146.00	(2)	(2)
Watercress	Bunch	1.00	92	½ cup	27.77	(3)	(3)

[1] Legal weights for contents of bushels, lugs, crates, and boxes vary among States.

[2] Number of purchase units needed is less than one.

[3] Number of purchase units needed is determined by use.

Canned vegetables as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Asparagus:							
Cuts and tips	No. 300 can	0. 88	61	3 ounces	2. 86	8¾	35
	No. 10 can	6. 31	60	do	20. 19	1¼	5
Spears	No. 300 can	. 91		6 medium	2. 57	9¾	39
	No. 10 can	6. 44		do	18. 53	1½	5½
Beans, lima, green	No. 303 can	1. 00	69	3 ounces	3. 68	7	27¼
	No. 10 can	6. 56	69	do	24. 14	1¼	4¼
Beans, snap, green or wax	No. 303 can	. 97	59	do	3. 05	8¼	33
	No. 2½ can	1. 75	59	do	5. 51	4¾	18¼
	No. 10 can	6. 31	62	do	20. 87	1¼	5
Beans, dry—kidney, lima, or navy	No. 303 can	1. 00	80	6 ounces	2. 13	11¾	47
	No. 10 can	6. 75	80	do	14. 40	1¾	6¾
Bean sprouts	do	6. 62	52	3 ounces	18. 37	1½	5½
Beets:							
Diced	No. 303 can	1. 00	66	do	3. 52	7¼	28½
	No. 10 can	6. 50	69	do	23. 92	1¼	4¼
Sliced	No. 303 can	1. 00	61	do	3. 25	7¾	31
	No. 10 can	6. 50	65	do	22. 53	1¼	4½
Whole baby beets	No. 303 can	1. 00	62	do	3. 31	7¾	30¼
	No. 10 can	6. 50	66	do	22. 88	1¼	4½
Carrots:							
Diced	No. 303 can	1. 00	62	do	3. 31	7¾	30¼
	No. 10 can	6. 50	69	do	23. 92	1¼	4¼
Sliced	No. 303 can	1. 00	62	do	3. 31	7¾	30¼
	No. 10 can	6. 50	66	do	22. 88	1¼	4½
Chop suey vegetables	do	6. 38	100	do	34. 00	(1)	3
Collards	No. 303 can	. 94	72	4 ounces	2. 71	9¼	37
	No. 2½ can	1. 69	70	do	4. 73	5½	21¼
	No. 10 can	6. 12	61	do	14. 93	1¾	6¾
Corn:							
Cream style	No. 303 can	1. 00	100	do	4. 00	6¼	25
	No. 10 can	6. 62	100	do	26. 48	1	4
Whole kernel	No. 303 can	1. 00	66	3 ounces	3. 52	7¼	28½
	No. 10 can	6. 62	66	do	23. 30	1¼	4½
Kale	No. 303 can	. 94	72	4 ounces	2. 71	9¼	37
	No. 2½ can	1. 69	70	do	4. 73	5½	21¼
	No. 10 can	6. 12	61	do	14. 93	1¾	6¾
Mushrooms	No. 8 Z	. 78	64	3 ounces	2. 66	9½	37¾
	No. 10 can	6. 44	66	do	22. 67	1¼	4½
Mustard greens	No. 303 can	. 94	72	4 ounces	2. 71	9¼	37
	No. 2½ can	1. 69	70	do	4. 73	5½	21¼
	No. 10 can	6. 12	61	do	14. 93	1¾	6¾
Okra	No. 303 can	. 97	68	3 ounces	3. 51	7¼	28½
	No. 10 can	6. 19	61	do	20. 14	1¼	5
Okra and tomatoes	No. 303 can	. 94	100	do	5. 01	5	20
	No. 10 can	6. 31	100	do	33. 65	(1)	3

See footnotes at end of table.

TABLE 10.—VEGETABLES—CANNED—Continued

Canned vegetables as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
Olives, large:							
Ripe:		*Pounds*	*Percent*		*Number*	*Number*	*Number*
Pitted	No. 1 tall	[2] 0. 47		2 olives	21. 33	1¼	4¾
Whole	do	[2]. 56		do	25. 60	1	4
	No. 10	[2] 4. 12		do	187. 69	[1]	[1]
Green, whole	Gallon	[2] 5. 50		do	250. 25	[1]	[1]
Onions, small, whole	No. 303 can	1. 00	56	3 ounces	2. 99	8½	33½
	No. 10 can	6. 31	59	do	19. 86	1½	5¼
Peas, green	No. 303 can	1. 00	64	do	3. 41	7½	29½
	No. 10 can	6. 56	64	do	22. 39	1¼	4½
Peas and carrots	No. 303 can	1. 00	69	do	3. 68	7	27¼
	No. 10 can	6. 56	69	do	24. 14	1¼	4¼
Pickles:							
Dill or sour:							
Sliced or cut	Quart jar	[2] 1. 38	100	1 ounce	22. 00	1¼	4¾
	No. 10 jar	[2] 4. 50	100	do	72. 00	[1]	1½
	Gallon jar	[2] 5. 62	100	do	90. 00	[1]	1¼
Whole	No. 2½ jar	[2] 1. 19	100	do	19. 00	1½	5½
	Quart jar	[2] 1. 31	100	do	21. 00	1¼	5
Sweet:							
Sliced or cut	do	[2] 1. 50	100	do	24. 00	1¼	4¼
	No. 10 jar	[2] 4. 88	100	do	78. 00	[1]	1½
	Gallon jar	[2] 5. 94	100	do	95. 00	[1]	1¼
Whole	No. 2½ jar	[2] 1. 28	100	do	20. 50	1¼	5
	Quart jar	[2] 1. 38	100	do	22. 00	1¼	4¾
Pickle relish:							
Sour	Quart	[2] 1. 61	100	do	25. 75	1	4
	No. 10 jar	[2] 5. 73	100	do	91. 75	[1]	1¼
	Gallon jar	[2] 7. 16	100	do	114. 50	[1]	[1]
Sweet	Quart	[2] 1. 75	100	do	28. 00	1	3¾
	No. 10 jar	[2] 6. 25	100	do	100. 00	[1]	1
	Gallon jar	[2] 7. 81	100	do	125. 00	[1]	[1]
Pimientos, chopped	No. 2½ can	1. 75	73	½ cup	4. 80	[3]	[3]
	No. 10 can	6. 81	68	do	17. 39	[3]	[3]
Potatoes, small whole	No. 2 can	1. 25		2–3	4. 00	6¼	25
	No. 10 can	6. 38		2–3	25. 00	1	4
Pumpkin, mashed	No. 300 can	. 91	100	4 ounces	3. 64	7	27½
	No. 2½ can	1. 81	100	do	7. 24	3½	14
	No. 10 can	6. 62	100	do	26. 50	1	4
Sauerkraut	No. 303 can	1. 00	82	3 ounces	4. 37	5¾	23
	No. 2½ can	1. 69	85	do	7. 66	3½	13¼
	No. 10 can	6. 19	81	do	26. 74	1	3¾

Soups:							
Condensed	No. 1 picnic	.66 to .75	200	1 cup diluted	2. 50	10	40
	No. 3 cylinder	3. 12	200	do	11. 50	2¼	8¾
Ready-to-serve	12-fluid-ounce can		100	1 cup	1. 50	16¾	66¾
	25-fluid-ounce can (No. 2½)		100	do	3. 12	8¼	32¼
Spinach	No. 303 can	. 94	72	4 ounces	2. 71	9¼	37
	No. 2½ can	1. 69	70	do	4. 73	5½	21¼
	No. 10 can	6. 12	61	do	14. 93	1¾	6¾
Squash, summer	No. 303 can	1. 00	69	do	2. 75	9¼	36½
	No. 10 can	6. 62	69	do	17. 50	1½	5¾
Squash, winter	No. 300 can	. 91	100	do	3. 64	7	27½
	No. 2½ can	1. 81	100	do	7. 24	3½	14
	No. 10 can	6. 62	100	do	26. 48	1	4
Succotash	No. 303 can	1. 00	65	3 ounces	3. 47	7¼	29
	No. 10 can	6. 75	65	do	23. 40	1¼	4½
Sweetpotatoes	No. 3 vacuum or squat	1. 44	65	4 ounces	3. 74	6¾	26¾
	No. 2½ can, with sirup	1. 81	66	do	4. 78	5¼	21
	No. 10 can, with sirup	6. 38	71	do	18. 00	1½	5¾
Tomatoes	No. 303 can	1. 00	100	do	4. 00	6¼	25
	No. 2½ can	1. 75	100	do	7. 00	3¾	14½
	No. 10 can	6. 38	100	do	25. 52	1	4
Tomato products:							
Catsup	14-ounce bottle	. 88	100	1 ounce	14. 00	2	7¼
	No. 10 can	6. 94	100	do	111. 00	(1)	1
Chili sauce	12-ounce jar	. 75	100	1 tablespoon	20. 27	1¼	5
	No. 10 can	6. 56	100	do	177. 30	(1)	(1)
Juice, concentrate [4]	6-fluid-ounce can	. 43	400	4 fluid ounces	6. 00	4¼	16¾
Turnip greens	No. 303 can	. 94	72	4 ounces	2. 71	9¼	37
	No. 2½ can	1. 69	70	do	4. 73	5½	21¼
	No. 10 can	6. 12	61	do	14. 93	1¾	6¾
Vegetable juices	23-fluid-ounce can	1. 54	100	4 fluid ounces	5. 75	4½	17½
	46-fluid-ounce can	3. 07	100	do	11. 50	2¼	8¾
	96-fluid-ounce can	6. 41	100	do	24. 00	1¼	4¼
Vegetables, mixed	No. 303 can	1. 00	68	3 ounces	3. 63	7	27¾
	No. 10 can	6. 50	68	do	23. 57	1¼	4¼

[1] Number of purchase units needed is less than one.
[2] Drained weight.
[3] Number of purchase units needed is determined by use.
[4] See vegetable juices for canned tomato juice.

TABLE 11.—VEGETABLES—FROZEN

Frozen vegetables as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Asparagus:							
Spears	Pound	1.00	----------	4 medium, cooked	3.38	7½	29¾
	Package	2.50	----------	---do	8.44	3	12
Cuts and tips	Pound	1.00	80	3 ounces cooked	4.27	6	23½
	Package	2.50	80	---do	10.67	2½	9½
Beans, butter (lima)	Pound	1.00	100	---do	5.33	4¾	19
	Package	2.50	100	---do	13.33	2	7½
	---do	3.00	100	---do	16.00	1¾	6¼
Beans, lima, green	Pound	1.00	100	---do	5.33	4¾	19
	Package	2.50	100	---do	13.33	2	7½
Beans, snap, green or wax	Pound	1.00	91	---do	4.85	5¼	20¾
	Package	2.50	91	---do	12.13	2¼	8¼
Blackeye peas	Pound	1.00	111	---do	5.92	4¼	17
	Package	2.50	111	---do	14.80	1¾	7
	---do	3.00	111	---do	17.76	1½	5¾
Broccoli:							
Spears	Pound	1.00	----------	2 medium	4.57	5½	22
	Package	2.50	----------	---do	11.43	2¼	8¾
Cut or chopped	Pound	1.00	85	3 ounces cooked	4.53	5¾	22¼
	Package	2.50	85	---do	11.33	2¼	9
Brussel sprouts	Pound	1.00	96	---do	5.12	5	19¾
	Package	2.50	96	---do	12.80	2	8
Carrots, sliced or diced	Pound	1.00	96	---do	5.12	5	19¾
	Package	2.50	96	---do	12.80	2	8
Cauliflower	Pound	1.00	90	---do	4.80	5¼	21
	Package	2.50	90	---do	12.00	2¼	8½
Collards	Pound	1.00	89	---do	4.75	5½	21¼
	Package	2.50	89	---do	11.87	2¼	8½
Corn:							
On cob	Pound (about three 5-inch ears).	1.00	----------	1 ear, cooked	3.00	8½	33½
Whole kernel	Pound	1.00	97	3 ounces cooked	5.17	5	19½
	Package	2.50	97	---do	12.93	2	7¾
Kale	Pound	1.00	77	---do	4.11	6¼	24½
	Package	2.50	77	---do	10.27	2½	9¾

	Package	2.50	80	do	10.67	2½	9½
	do	3.00	80	do	12.80	2	8
Okra, whole	Pound	1.00	82	do	4.37	5¾	23
	Package	2.50	82	do	10.93	2½	9¼
	do	3.00	82	do	13.12	2	7¾
Peas, green	Pound	1.00	96	do	5.12	5	19¾
	Package	2.50	96	do	12.80	2	8
	do	3.00	96	do	15.36	1¾	6¾
Peas and carrots	Pound	1.00	98	do	5.23	5	19¼
	Package	2.50	98	do	13.07	2	7¾
Peppers, green:							
Whole	do	1.00		½ pepper, cooked	12.00	2¼	8½
	do	2.50		do	30.00	(1)	3½
Diced or sliced	Pound	1.00	97	1 ounce cooked	15.52	1¾	6½
	Package	2.50	97	do	38.80	(1)	2¾
Potatoes:							
French fried	do	1.00		10 pieces	8.00	3¼	12½
	do	5.00		do	40.00	(1)	2½
Small whole	Container	5.00		3 cooked	16.67	1½	6
Spinach	Pound	1.00	80	3 ounces cooked	4.27	6	23½
	Package	2.50	80	do	10.67	2½	9½
	do	3.00	80	do	12.80	2	8
Squash, summer, sliced	Pound	1.00	87	do	4.64	5½	21¾
	Package	2.50	87	do	11.60	2¼	8¾
	do	3.00	87	do	13.92	2	7¼
Squash, winter, mashed	Pound	1.00	92	4 ounces cooked	3.68	7	27¼
	Package	2.50	92	do	9.20	2¾	11
Sweetpotatoes:							
Whole	Pound	1.00		1 whole, cooked	2.63	9¾	38¼
	do	1.00	98	4 ounces cooked	3.92	6½	25¾
Sliced	Package	2.50	98	do	9.80	2¾	10¼
	do	3.00	98	do	11.76	2¼	8¾
Succotash	Pound	1.00	106	3 ounces cooked	5.65	4½	17¾
	Package	2.50	106	do	14.13	2	7¼
Turnip greens, leaf or chopped	Pound	1.00	80	do	4.27	6	23½
	Package	2.50	80	do	10.67	2½	9½
	do	3.00	80	do	12.80	2	8
Turnip greens with turnips	Pound	1.00	89	do	4.75	5½	21¼
	Package	3.00	89	do	14.24	2	7¼
Vegetables, mixed	Pound	1.00	95	do	5.07	5	19¾
	Package	2.50	95	do	12.67	2	8

[1] Number of purchase units needed is less than one.

TABLE 12.—VEGETABLES—DRIED

Vegetables, dried, regular and low-moisture, as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
REGULAR		*Pounds*	*Percent*		*Number*	*Number*	*Number*
Beans (includes white beans, lima beans, kidney beans, blackeye beans or peas).	Pound	1.00	232	3 ounces cooked	12.37	2¼	8¼
Peas (includes any type, whole peas, split peas, or lentils).	do	1.00	223	do	11.89	2¼	8½
	Bushel	60.00	223	do	713.60	(1)	(1)
LOW-MOISTURE							
Onions, sliced	Pound	1.00	417	do	22.24	1¼	4½
Potatoes, white:							
Flakes	do	1.00	521	4 ounces cooked	20.84	1¼	5
	Package	2.50	521	do	52.10	(1)	2
Granules	Pound	1.00	506	do	20.24	1¼	5
	Package	2.50	506	do	50.60	(1)	2
Sweetpotatoes, flakes	Pound	1.00	294	do	11.76	2¼	8¾

[1] Number of purchase units needed is less than one.

Fresh fruits as purchased	Unit of purchase	Weight per unit [1]	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Apples	Pound	1.00		1 medium, baked or raw	3.00	8½	33½
	Bushel	40.00		do	120.00	(2)	(2)
	Pound	1.00	76	2 ounces raw, chopped or diced	6.08	4¼	16½
	do	1.00	87	4 ounces applesauce	3.48	7¼	28¾
	do	1.00	63	4 ounces cooked, sliced or diced	2.52	10	39¾
	do	1.00		⅙ 9-inch pie (2.12 pounds of apples per pie).	2.83	9	35½
	do	1.00		⅛ 9-inch pie	3.77	6¾	26¾
Apricots	do	1.00		2 medium	6.00	4¼	16¾
	Lug	24.00		do	144.00	(2)	(2)
Avocados	Pound	1.00	75	2 ounces sliced, diced, or wedges	6.00	4¼	16¾
	Lug	12.00	75	do	72.00	(2)	1½
	Box (⅘ bushel)	36.00	75	do	216.00	(2)	(2)
Bananas	Pound	1.00		1 medium	3.00	8½	33½
	Box	25.00		do	75.00	(2)	1½
	Pound	1.00	68	2 ounces sliced for fruit cup	5.44	4¾	18½
	do	1.00	68	3 ounces sliced for dessert	3.63	7	27¾
	do	1.00	68	4 ounces mashed	2.72	9¼	37
Blackberries	Quart	1.42	95	1 ounce salad garnish	21.53	1¼	4¾
	do	1.42	95	3 ounces	7.18	3½	14
	Crate (24 quarts)	34.00	95	do	172.22	(2)	(2)
	Quart	1.42		⅙ 9-inch pie (0.92 quart per pie)	6.54	4	15½
	do	1.42		⅛ 9-inch pie	8.70	3	11½
Blueberries	do	1.97	92	1 ounce salad garnish	28.98	(2)	3½
	do	1.97	92	3 ounces	9.66	2¾	10½
	Crate (24 quarts)	47.25	92	do	231.84	(2)	(2)
	Quart	1.97		⅙ 9-inch pie (0.59 quart per pie)	10.20	2½	10
	do	1.97		⅛ 9-inch pie	13.51	2	7½
Cantaloup	Pound	1.00	50	3 ounces sliced or diced	2.67	9½	37½
	1 (No. 36 size)	2.50		½ medium	2.00	12½	50
	Crate (No. 36)	80.00		do	64.00	(2)	1¾
Cherries	Pound	1.00	89	3 ounces pitted, raw	4.75	5½	21¼
	Lug	16.00	89	do	75.95	(2)	1½
	Pound	1.00		⅙ 9-inch pie (1.60 pounds per pie)	3.75	6¾	26¾
	do	1.00		⅛ 9-inch pie	5.00	5	20
Cranberries	do	1.00	96	1 ounce raw, chopped, for relish	15.36	1¾	6¾
	do	1.00	182	2 ounces sauce, strained	14.56	1¾	7
	do	1.00	239	2 ounces cooked, whole	19.12	1½	5¼
	Box	25.00	239	do	478.00	(2)	(2)
Figs	Pound	1.00		3 medium	4.00	6¼	25
	Box	6.00		do	24.00	1¼	4¼

See footnotes at end of table.

TABLE 13.—FRUITS—FRESH—Continued

Fresh fruits as purchased	Unit of purchase	Weight per unit [1]	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Grapefruit	Pound	1.00	44	4 fluid ounces juice	1.61	15¾	62¼
	Dozen (No. 64 size)	15.00	44	do	24.22	1¼	4¼
	Pound	1.00	47	4 ounces segments	1.88	13½	53¼
	Dozen	15.00	47	do	28.20	(2)	3¾
	do	15.00		½ medium	24.00	1¼	4¼
Grapefruit segments	½-gallon jar	4.22	100	4 ounces	16.88	1½	6
Grapes:							
With seeds	Pound	1.00	89	4 ounces, seeds removed	3.56	7¼	28¼
Seedless	do	1.00	94	4 ounces	3.76	6¾	26¾
	Lug	24.00	94	do	90.24	(2)	1¼
Honeydew melon	Pound	1.00	60	3 ounces sliced or diced	3.20	8	31¼
	1 melon	4.00		Wedge, ⅛ melon	8.00	3¼	12½
	do	4.00	60	3 ounces sliced or diced	12.80	2	8
Lemons	1 lemon (medium)	.23		1 slice	8.00	3¼	12½
	do	.23		1 wedge	6.00	4¼	16¾
	Pound (about 4 lemons)	1.00	43	2 fluid ounces juice	3.16	8	31¾
	Carton	36.00	43	do	113.76	(2)	(2)
Limes	1 lime (medium)	.15		Wedge, ¼ lime	4.00	6¼	25
	Pound	1.00	48	2 fluid ounces juice	3.52	7¼	28½
	Box (⅘ bushel)	40.00	48	do	140.80	(2)	(2)
Mangoes	Pound	1.00	67	3 ounces sliced or diced	3.57	7¼	28¼
	Lug	24.00	67	do	85.76	(2)	1¼
Oranges	Pound	1.00	50	4 fluid ounces juice	1.83	13¾	54¾
	do	1.00	56	4 ounces sections (no membrane)	2.24	11¼	44¾
	do	1.00	70	4 ounces sections (with membrane)	2.80	9	35¾
California	Carton	38.00	70	do	106.40	(2)	(2)
Florida	Box	85.00	50	4 fluid ounces juice	155.55	(2)	(2)
Medium No. 176	Pound	1.00		1 whole	2.00	12½	50
	Dozen	6.00	50	4 fluid ounces juice	11.01	2½	9¼
	do	6.00	56	4 ounces sections (no membrane)	13.44	2	7½
Small No. 250	Pound	1.00		1 whole	3.00	8½	33½
	Dozen	4.00	50	4 fluid ounces juice	7.34	3½	13¾
	do	4.00	56	4 ounces sections (no membrane)	8.96	3	11¼
Orange segments	½-gallon jar	4.28	100	4 ounces	17.12	1½	6
Peaches	Pound	1.00		1 medium	4.00	6¼	25
	do	1.00	76	3 ounces sliced or diced	4.05	6¼	24¾
	Bushel	48.00	76	do	194.56	(2)	(2)
	Pound	1.00		⅙ 9-inch pie (1.88 pound per pie)	3.19	8	31½
	do	1.00		⅛ 9-inch pie	4.26	6	23½
Pears	do	1.00		1 medium	3.00	8½	33½
	do	1.00	78	3 ounces sliced or diced	4.16	6¼	24¼
	Bushel	46.00	78	do	191.36	(2)	(2)

	½ crate	35.00	52	do	97.07	(2)	1¼
Pineapple chunks	½-gallon jar	4.36	100	4 ounces	17.44	1½	5¾
Plums	Pound	1.00	----------	3 medium	2.67	9½	37½
	do	1.00	94	3 ounces halves pitted	5.01	5	20
	4-basket crate	28.00	94	do	140.37	(2)	(2)
Raspberries	Quart	1.47	97	1 ounce salad garnish	22.87	1¼	4½
	do	1.47	97	3 ounces	7.62	3½	13¼
	Crate (24 quarts)	35.00	97	do	181.07	(2)	(2)
	Quart	1.46	----------	⅙ 9-inch pie (0.68 quart per pie)	8.85	3	11½
	do	1.46	----------	⅛ 9-inch pie	11.76	2¼	8¾
Rhubarb, trimmed	Pound	1.00	103	3 ounces cooked	5.49	4¾	18¼
	do	1.00	----------	⅙ 9-inch pie (1.44 pounds per pie)	4.17	6	24
	do	1.00	----------	⅛ 9-inch pie	5.56	4½	18
Strawberries	Quart	1.48	87	1 ounce salad garnish	20.53	1¼	5
	do	1.48	87	3 ounces	6.84	3¾	14¾
	Crate (24 quarts)	35.00	87	do	162.40	(2)	(2)
	Quart	1.46	----------	⅙ 9-inch pie (1 quart per pie)	6.00	4¼	16¾
	do	1.46	----------	⅛ 9-inch pie	8.00	3¼	12½
Tangerines	Pound	1.00	----------	1 medium	4.00	6¼	25
	Box	45.00	----------	do	180.00	(2)	(2)
	Pound	1.00	74	3 ounces sections	3.95	6½	25½
Watermelon	do	1.00	46	3 ounces	2.45	10¼	41
	1 melon	18 to 30	----------	1/16 melon	16.00	1¾	6¼

[1] Legal weights for contents of bushels, lugs, crates, and boxes vary among States.

[2] Number of purchase units needed is less than one.

TABLE 14.—FRUITS—CANNED

Canned fruits as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Apples, solid pack	No. 2 can	1. 12	100	4 ounces	4. 48	5¾	22½
	No. 2½ can	1. 62	100	do	6. 48	4	15½
	No. 10 can	6. 00	100	4 ounces	24. 00	1¼	4¼
				⅙ 9-inch pie	24. 00	1¼	4¼
Apple juice	23-fluid-ounce can	1. 57	100	4 fluid ounces	5. 75	4½	17½
	46-fluid-ounce can	3. 14	100	do	11. 50	2¼	8¾
	96-fluid-ounce can	6. 56	100	do	24. 00	1¼	4¼
Applesauce	No. 303 can	1. 00	100	4 ounces	4. 00	6¼	25
	No. 2½ can	1. 81	100	do	7. 24	3½	14
	No. 10 can	6. 75	100	do	27. 00	1	3¾
Apricots, halves	No. 303 can	1. 00	----------	3–5 medium	4. 00	6¼	25
	No. 2½ can	1. 88	----------	do	7. 00	3¾	14½
	No. 10 can	6. 62	----------	do	25. 00	1	4
Blackberries	No. 303 can	1. 00	100	4 ounces	4. 00	6¼	25
	No. 10 can	6. 62	100	do	26. 48	1	4
Blueberries	No. 300 can	. 91	100	do	3. 64	7	27½
	No. 10 can	6. 56	100	do	26. 24	1	4
Boysenberries	No. 303 can	. 94	100	do	3. 76	6¾	26¾
	No. 10 can	6. 62	100	do	26. 48	1	4
Cherries:							
Red, sour, pitted	No. 303 can	1. 00	100	do	4. 00	6¼	25
	No. 10 can	6. 56	100	4 ounces	26. 24	1	4
				⅙ 9-inch pie	24. 00	1¼	4¼
Sweet	No. 303 can	1. 00	100	4 ounces	4. 00	6¼	25
	No. 2½ can	1. 81	100	do	7. 24	3½	14
	No. 10 can	6. 75	100	do	27. 00	1	3¾
Cranberries, strained or whole	No. 300 can	1. 00	100	2 ounces	8. 00	3¼	12½
	No. 10 can	7. 31	100	do	58. 50	(1)	1¾
Cranberry juice	1 pint	1. 11	100	4 fluid ounces	4. 00	6¼	25
	1 quart	2. 23	100	do	8. 00	3¼	12½
	1 gallon	8. 92	100	do	32. 00	(1)	3¼
Figs	No. 303 can	1. 06	----------	3–4 figs	4. 00	6¼	25
	No. 2½ can	1. 88	----------	do	7. 00	3¾	14¼

	No. 2½ can	1. 88	100	do	7. 52	3½	13½
	No. 10 can	6. 75	100	do	27. 00	1	3¾
Grapefruit juice	18-fluid-ounce can	1. 24	100	4 fluid ounces	4. 50	5¾	22¼
	46-fluid-ounce can	3. 14	100	do	11. 50	2¼	8¾
	96-fluid-ounce can	6. 57	100	do	24. 00	1¼	4¼
Grapefruit sections	No. 303 can	1. 00	100	4 ounces	4. 00	6¼	25
	No. 3 cylinder	3. 12	100	do	12. 48	2¼	8¼
Lemon juice	32 fluid-ounce can	2. 16	100	2 fluid ounces	16. 00	1¾	6¼
Lime juice	do	2. 17	100	do	16. 00	1¾	6¼
Orange juice	18-fluid-ounce can	1. 24	100	4 fluid ounces	4. 50	5¾	22¼
	46-fluid-ounce can	3. 16	100	do	11. 50	2¼	8¾
	96-fluid-ounce can	6. 59	100	do	24. 00	1¼	4¼
Oranges, mandarin	No. 10 can	6. 38	100	4 ounces	25. 50	1	4
Peaches:							
Halves or slices	No. 303 can	1. 00		2 medium	3. 00	8½	33½
	No. 2½ can	1. 81		do	7. 00	3¾	14½
	No. 10 can	6. 75		{2 medium	25. 00	1	4
				{⅙ 9-inch pie	24. 00	1¼	4¼
Whole, spiced	do	6. 88		1 each	25. 00	1	4
Pears, halves	No. 303 can	1. 00		2 medium	3. 00	8½	33½
	No. 2½ can	1. 81		do	7. 00	3¾	14½
	No. 10 can	6. 62		do	25. 00	1	4
Pineapple:							
Chunks and cubes	No. 2½ can	1. 88	100	4 ounces	7. 52	3½	13½
	No. 10 can	6. 75	100	do	27. 00	1	3¾
Crushed	No. 2½ can	1. 88	100	do	7. 52	3½	13½
	No. 10 can	6. 81	100	do	27. 24	1	3¾
Sliced	No. 2½ can	1. 88		1 large	8. 00	3¼	12½
	No. 10 can	6. 81		1 large or 2 small	25. 00	1	4
Pineapple juice	18-fluid-ounce can	1. 24	100	4 fluid ounces	4. 50	5¾	22¼
	46-fluid-ounce can	3. 17	100	do	11. 50	2¼	8¾
	96-fluid-ounce can	6. 62	100	do	24. 00	1¼	4¼
Plums	No. 2½ can	1. 88		2–3 plums	7. 00	3¾	14½
	No. 10 can	6. 75		do	25. 00	1	4
Prunes	No. 2½ can	1. 88	100	4 ounces	7. 52	3½	13½
	No. 10 can	6. 88	100	do	27. 52	1	3¾
Raspberries	No. 303 can	1. 00	100	do	4. 00	6¼	25
	No. 10 can	6. 75	100	do	27. 00	1	3¾
Strawberries	No. 303 can	1. 00	100	do	4. 00	6¼	25
	No. 10 can	6. 75	100	do	27. 00	1	3¾

[1] Number of purchase units needed is less than one.

TABLE 15.—FRUITS—FROZEN

Frozen fruits as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Apples, sliced	Pound	1.00	106	4 ounces	4.24	6	23¾
				⅙ 9-inch pie (1.50 pounds per pie).	4.00	6¼	25
	Package	2.50	106	4 ounces	10.60	2½	9½
	do	5.00	106	do	21.20	1¼	4¾
	Can	30.00	106	do	127.20	(1)	(1)
Apricots	Pound	1.00	95	do	3.80	6¾	26½
	Can	25.00	95	do	95.00	(1)	1¼
	do	30.00	95	do	114.00	(1)	(1)
Blackberries	Pound	1.00	103	do	4.12	6¼	24½
	Can	30.00	103	do	123.60	(1)	(1)
Blueberries	Pound	1.00	108	do	4.32	6	23¼
	Package	2.50	108	do	10.80	2½	9½
	Can	25.00	108	do	108.00	(1)	1
	do	30.00	108	do	129.60	(1)	(1)
Cherries, red, sour, pitted	Pound	1.00	100	4 ounces	4.00	6¼	25
				⅙ 9-inch pie (1.50 pounds per pie).	4.00	6¼	25
	Can	30.00	100	4 ounces	120.00	(1)	(1)
Grapefruit sections	Pound	1.00	100	do	4.00	6¼	25
	Package	3.00	100	do	12.00	2¼	8½
Grapefruit juice, concentrate	6-fluid-ounce can	.46	400	4 fluid ounces	6.00	4¼	16¾
	32-fluid-ounce can	2.46	400	do	32.00	(1)	3¼
Grape juice, concentrate	6-fluid-ounce can	.48	400	do	6.00	4¼	16¾
	32-fluid-ounce can	2.54	400	do	32.00	(1)	3¼
Lemon juice, concentrate	4-fluid-ounce can	.31	500	2 fluid ounces	10.00	2½	10
	6-fluid-ounce can	.47	500	do	15.00	1¾	6¾
Lemonade, concentrate	6-fluid-ounce can	.49	700	do	21.00	1¼	5
	18-fluid-ounce can	1.46	700	do	63.00	(1)	1¾
Melon scoops	Pound	1.00	100	3 ounces	5.33	4¾	19
	Package	2.00	100	do	10.67	2¼	9½

	12-fluid-ounce can	.93	400	do	12.00	2¼	8½
	32-fluid-ounce can	2.48	400	do	32.00	(1)	3¼
Peaches, sliced	Pound	1.00	95	4 ounces	3.80	6¾	26½
				⅙ 9-inch pie (1.33 pounds per pie).	4.50	5¾	22¼
	Can	6.50	95	4 ounces	24.70	1¼	4¼
	do	10.00	95	do	38.00	(1)	2¾
	do	30.00	95	do	114.00	(1)	(1)
Pineapple:							
Chunks	Pound	1.00	100	do	4.00	6¼	25
	Can	10.00	100	do	40.00	(1)	2½
Crushed	do	30.00	100	do	120.00	(1)	(1)
Pineapple juice, concentrate	6-fluid-ounce can	.47	400	4 fluid ounces	6.00	4¼	16¾
	32-fluid-ounce can	2.53	400	do	32.00	(1)	3¼
Raspberries	Pound	1.00	100	4 ounces	4.00	6¼	25
	Can	6.50	100	do	26.00	1	4
	do	10.00	100	do	40.00	(1)	2½
	do	30.00	100	do	120.00	(1)	(1)
Rhubarb	Pound	1.00	106	4 ounces	4.24	6	23¾
				⅙ 9-inch pie (1.50 pounds per pie).	4.00	6¼	25
	Package	2.50	106	4 ounces	10.60	2½	9½
	Can	10.00	106	do	42.40	(1)	2½
	do	25.00	106	do	106.00	(1)	1
	do	30.00	106	do	127.20	(1)	(1)
Strawberries	Pound	1.00	100	do	4.00	6¼	25
	Can	6.50	100	do	26.00	1	4
	do	10.00	100	do	40.00	(1)	2½
	do	30.00	100	do	120.00	(1)	(1)
Tangerine juice, concentrate	6-fluid-ounce can	.47	400	4 fluid ounces	6.00	4¼	16¾
	32-fluid-ounce can	2.48	400	do	32.00	(1)	3¼

[1] Number of purchase units needed is less than one.

TABLE 16.—FRUITS—DRIED

Fruits, dried, regular and low-moisture, as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
REGULAR		*Pounds*	*Percent*		*Number*	*Number*	*Number*
Apple slices	Pound	1.00	412	4 ounces	16.48	1¾	6¼
				⅙ 9-inch pie (⅓ pound per pie)	18.00	1½	5¾
	Carton	5.00	412	4 ounces	82.40	(1)	1¼
Apricots	11-ounce package	.69	344	do	9.46	2¾	10¾
	Pound	1.00	344	do	13.76	2	7½
	Carton	30.00	344	do	412.80	(1)	(1)
Dates	12-ounce package	.75	100	3 ounces	4.00	6¼	25
	Pound	1.00	100	do	5.33	4¾	19
	Carton	15.00	100	do	80.00	(1)	1¼
Peaches	11-ounce package	.69	422	4 ounces	11.60	2¼	8¾
	Pound	1.00	422	4 ounces	16.88	1½	6
				⅙ 9-inch pie (⅓ pound per pie)	18.00	1½	5¾
	Carton	30.00	422	4 ounces	506.40	(1)	(1)
Prunes	Pound	1.00	253	do	10.12	2½	10
	2-pound package	2.00	253	do	20.24	1¼	5
	Carton	30.00	253	do	303.60	(1)	(1)
Raisins	Pound	1.00	100	½ cup	6.00	4¼	16¾
LOW-MOISTURE							
Apples	Pound	1.00	584	4 ounces	23.36	1¼	4½
				⅙ 9-inch pie (¼ pound per pie).	24.00	1¼	4¼
	No. 10 can	1.50	584	4 ounces	35.04	(1)	3
Applesauce	Pound	1.00	911	do	36.44	(1)	2¾
	No. 10 can	2.50	911	do	91.10	(1)	1¼
Apricots	Pound	1.00	505	do	20.20	1¼	5
	No. 10 can	3.50	505	do	70.70	(1)	1½
Fruit cocktail	Pound	1.00	558	do	22.32	1¼	4½
	No. 10 can	2.75	558	do	61.38	(1)	1¾
				4 ounces	21.36	1¼	4¾
Peaches	Pound	1.00	534	⅙ 9-inch pie (¼ pound per pie).	24.00	1¼	4¼
	No. 10 can	3.00	534	4 ounces	64.08	(1)	1¾
Prunes, whole, pitted	Pound	1.00	462	do	18.48	1½	5½
	No. 10 can	3.00	462	do	55.44	(1)	2

[1] Number of purchase units needed is less than one.

Flour, cereals, and mixes as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served or used	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Flour	5-pound bag	5.00		1 cup	20.00	(1)	(1)
	25-pound bag	25.00		do	100.00	(1)	(1)
	100-pound sack	100.00		do	400.00	(1)	(1)
Cereals, uncooked:							
Bulgur, cracked wheat (USDA)	Pound	1.00	401	¾ cup cooked	10.67	2½	9½
				1 cup uncooked	2.67	(1)	(1)
Cornmeal	1-pound box	1.00	628	¾ cup cooked	15.33	1¾	6¾
	5-pound bag	5.00	628	do	76.65	(2)	1½
	10-pound bag	10.00	628	do	153.30	(2)	(2)
	1-pound box	1.00	100	1 cup uncooked	3.00	(1)	(1)
Corn grits	do	1.00	628	¾ cup cooked	16.43	1¾	6¼
	do	1.00	100	1 cup uncooked	2.75	(1)	(1)
Farina	do	1.00	855	¾ cup cooked	21.92	1¼	4¾
	5-pound bag	5.00	855	do	109.60	(2)	1
Macaroni	1-pound box	1.00	311	do	12.00	2¼	8½
	20-pound box	20.00	311	do	240.00	(2)	(2)
	1-pound box	1.00	100	1 cup uncooked	3.75	(1)	(1)
Noodles	do	1.00	329	¾ cup cooked	10.67	2½	9½
	20-pound box	20.00	329	do	213.40	(2)	(2)
	1-pound box	1.00	100	1 cup uncooked	7.25	(1)	(1)
Rice	do	1.00	320	¾ cup cooked	11.27	2¼	9
	10-pound box	10.00	320	do	112.70	(2)	(2)
	100-pound sack	100.00	320	do	1,127.00	(2)	(2)
	1-pound box	1.00	100	1 cup uncooked	2.75	(1)	(1)
Rolled oats	do	1.00	610	¾ cup cooked	15.33	1¾	6¾
	3-pound box	3.00	610	do	46.00	(2)	2¼
	50-pound sack	50.00	610	do	766.50	(2)	(2)
	1-pound box	1.00	100	1 cup uncooked	4.50	(1)	(1)
Rolled wheat (USDA)	do	1.00	375	¾ cup cooked	8.89	3	11¼
	3-pound box	3.00	375	do	26.67	(2)	3¾
Spaghetti	1-pound box	1.00	359	do	12.12	2¼	8¼
	20-pound box	20.00	359	do	242.40	(2)	(2)
	1-pound box	1.00	100	1 cup uncooked	6.06	(1)	(1)
Whole wheat	do	1.00	608	¾ cup cooked	15.20	1¾	6¾
	4½-pound box	4.50	608	do	68.40	(2)	1½
	50-pound sack	50.00	608	do	760.00	(2)	(2)

See footnotes at end of table.

TABLE 17.—FLOUR, CEREALS, AND MIXES—Continued

Flour, cereals, and mixes as purchased	Unit of purchase	Weight per unit	Yield, as served	Portion as served or used	Portions per purchase unit	Approximate purchase units for—	
						25 portions	100 portions
		Pounds	*Percent*		*Number*	*Number*	*Number*
Cereals, ready-to-eat:							
Bran flakes (25–40%)	Pound	1.00	100	1 ounce	16.00	1¾	6¼
	14½-ounce package	.91	100	do	14.50	1¾	7
	10-pound package	10.00	100	do	160.00	(2)	(2)
Bran flakes with raisins	Pound	1.00	100	1¼ ounces	12.80	2	8
	14-ounce package	.88	100	do	11.20	2¼	9
	200 individuals	15.62	100	do	200.00	(2)	(2)
Corn flakes	Pound	1.00	100	1 ounce	16.00	1¾	6¼
	12-ounce package	.75	100	do	12.00	2¼	8½
	10-pound package	10.00	100	do	160.00	(2)	(2)
Puffed rice	Pound	1.00	100	⅝ ounce	25.60	1	4
	8-ounce package	.50	100	do	12.80	2	8
	10-pound package	10.00	100	do	256.00	(2)	(2)
Puffed wheat	Pound	1.00	100	½ ounce	32.00	(2)	3¼
	8-ounce package	.50	100	do	16.00	1¾	6¼
	10-pound package	10.00	100	do	320.00	(2)	(2)
Puffed wheat, presweetened	Pound	1.00	100	⅞ ounce	18.29	1½	5½
	9-ounce package	.56	100	do	10.29	2½	9¾
	200 individuals	10.94	100	do	200.00	(2)	(2)
Rice flakes	Pound	1.00	100	do	18.29	1½	5½
	9½-ounce package	.59	100	do	10.86	2½	9¼
	10-pound package	10.00	100	do	182.86	(2)	(2)
Shredded wheat	Pound	1.00	100	1⅗ ounces	10.00	2½	10
	12-ounce package	.75	100	1⅗ ounces (2 small)	7.50	3½	13½
	200 individuals	20.00	100	1⅗ ounces	200.00	(2)	(2)
Wheat flakes	Pound	1.00	100	1 ounce	16.00	1¾	6¼
	10-ounce package	.62	100	do	10.00	2½	10
	10-pound package	10.00	100	do	160.00	(2)	(2)
Mixes: [3]							
Cake:							
Angel food	Pound	1.00	----------	1/12 10-in. cake	12.00	2¼	8½
	12-cake case	12.00	----------	do	144.00	(2)	(2)
Other	Pound	1.00	----------	2 in. x 3 in. cut	15–20	1¾	6¾
				Cupcake	20.00	1¼	5
	5-pound box	5.00	----------	2 in. x 3 in. cut	75–100	(2)	1½
				Cupcake	100.00	(2)	1
Frosting	Pound	1.00	----------	2 in. x 2 in	38–39	(2)	2¾
				Cupcake	36–37	(2)	3
	5-pound box	5.00	----------	2 in. x 2 in	190–195	(2)	(2)
				Cupcake	180–185	(2)	(2)

Cookie:							
Basic sugar	Pound	1.00		2 ½-ounce cookies	17–20	1½	6
	5-pound box	5.00		do	85–100	(2)	1¼
Brownie	Pound	1.00		2 in. x 2 in.	20–30	1¼	5
	5-pound box	5.00		do	100–150	(2)	1
Hot bread:							
Biscuit	Pound	1.00		2-inch biscuit	20.00	1¼	5
	5-pound box	5.00		do	100.00	(2)	1
Muffins	Pound	1.00		1½-ounce muffin	14–16	2	7¼
	5-pound box	5.00		do	70–80	(2)	1½
Rolls:							
Sweet	Pound	1.00		1¼-ounce roll	18–19	1½	5¾
	5-pound box	5.00		do	90–95	(2)	1¼
Yeast	Pound	1.00		1-ounce roll	23–25	1¼	4½
	5-pound box	5.00		do	115–120	(2)	(2)
Piecrust	Pound	1.00		9-inch shell	3.00	8½	33½
	5-pound box	5.00		do	16.00	1¾	6¼

[1] Number of purchase units needed is determined by use.
[2] Number of purchase units needed is less than one.
[3] Yields of mixes vary widely, depending on manufacturer, size of pan, and baking time and temperature. See instructions on package or box.

TABLE 18.—BAKERY FOODS

Bakery foods as purchased	Unit of purchase	Weight per unit	Portion as served	Portions per purchase unit	Approximate purchase units for—	
					25 portions	100 portions
Bread: [1]		*Pounds*		*Number*	*Number*	*Number*
Raisin	1-pound loaf	1.00	1 slice	18.00	1½	5¾
	2-pound loaf	2.00	do	36.00	(2)	3
Rye	1-pound loaf	1.00	do	23.00	1¼	4½
	1½-pound loaf	1.50	do	28.00	1	3¾
	2-pound loaf	2.00	do	33.00	(2)	3¼
White and whole wheat	1-pound loaf	1.00	⅝-inch slice	16.00	1¾	6¼
	1¼-pound loaf	1.25	do	19.00	1½	5½
	1½-pound loaf	1.50	do	24.00	1¼	4¼
	2-pound loaf	2.00	½-inch slice	28.00	1	4
			⅜-inch slice	36.00	(2)	3
	3-pound loaf	3.00	½-inch slice	44.00	(2)	2½
			⅜-inch slice	56.00	(2)	2
Cake:						
Layer	8-inch		1/12 cake	12.00	2¼	8½
	9-inch		1/16 cake	16.00	1¾	6¼
	12-inch		1/30 cake	30.00	(2)	3½
	14-inch		1/40 cake	40.00	(2)	2½
Loaf	Pound	1.00	⅛ cake	8.00	3¼	12½
			1 cup soft cubes or crumbs	18.00	1½	5¾
			1 cup toasted cubes	13.50	2	7½
			1 cup dry crumbs	6.00	4¼	16¾
Sheet	8-inch square		2 in. x 2 in. (small)	16.00	1¾	6¼
	9 in. x 13 in		3 in. x 3 in. (regular)	12.00	2¼	8½
	12 in. x 10 in		2 in. x 2 in	54.00	(2)	2
			3 in. x 3 in	24.00	1¼	4¼
	16 in. x 24 in		2 in. x 2 in	96.00	(2)	1¼
			3 in. x 3 in	40.00	(2)	2½
Cookies:						
Brownies	Pound	1.00	2 cookies	18.00	1½	5¾
Butter	do	1.00	do	46.50	(2)	2¼
Chocolate chip	do	1.00	do	21.50	1¼	4¾
Cream filled	do	1.00	do	19.50	1½	5¼
Fig bars	do	1.00	do	15.50	1¾	6½
Ginger snaps	do	1.00	do	30.00	(2)	3½
Shortbread	do	1.00	do	29.00	(2)	3½
Sugar	do	1.00	do	10.50	2½	9¾
Vanilla	do	1.00	do	46.50	(2)	2¼
Crackers:						
Graham	do	1.00	2 crackers	32.50	(2)	3¼
Saltines	do	1.00	do	65–70	(2)	1¾
Soda	do	1.00	do	30–35	(2)	3¼

Rolls:						
Frankfurter	do	1.00	1 roll (1⅓ ounces)	12.03	2¼	8½
Hamburger	do	1.00	1 roll (1¾ ounces)	9.14	2¾	11
Hard, round	do	1.00	1 roll (1⅚ ounces)	8.74	3	11½
Plain, pan	do	1.00	1 roll (1⅓ ounces)	12.03	2¼	8½
Sweet, pan	do	1.00	1 roll (1½ ounces)	10.67	2½	9½
Pie	8-inch		⅙ pie	6.00	4¼	16¾
	9-inch		⅐ pie	7.00	3¾	14½
	10-inch		⅛ pie	8.00	3¼	12½

[1] End crusts of bread were excluded in determining portions per purchase unit.

[2] Number of purchase units needed is less than one.

TABLE 19.—FATS AND OILS

Fats and oils as purchased	Unit of purchase	Weight per unit	Portion as served or used	Portions per purchase unit	Approximate purchase units for—	
					25 portions	100 portions
		Pounds		*Number*	*Number*	*Number*
Butter or margarine:						
Pound print	Carton	1.00	1 cup	2.00	[1]	[1]
			1 pat	72.00	[2]	1½
¼-pound print	do	1.00	1 pat	72.00	[2]	1½
Chips	Case	5.00	do	360.00	[2]	[2]
Lard	Carton	1.00	1 cup	2.00	[1]	[1]
	Can	50.00	do	100.00	[1]	[1]
Salad dressing (oil or mayonnaise type)	Pint	1.00	1 tablespoon	32.00	[2]	3¼
	Quart	2.00	do	64.00	[2]	1¾
	Gallon	8.00	do	256.00	[2]	[2]
Salad oil	Pint	.97	1 cup	2.00	[1]	[1]
	Quart	1.94	do	4.00	[1]	[1]
	Gallon	7.76	do	16.00	[1]	[1]
Shortening (Hydrogenated)	Can	1.00	do	2.50	[1]	[1]
	do	3.00	do	7.50	[1]	[1]
	do	50.00	do	125.00	[1]	[1]

[1] Number of purchase units needed is determined by use.

[2] Number of purchase units needed is less than one.

TABLE 20.—SUGAR AND SWEETS

Sugar and sweets as purchased	Unit of purchase	Weight per unit	Portion as served or used	Portions per purchase unit	Approximate purchase units for—	
					25 portions	100 portions
Sugar:		*Pounds*		*Number*	*Number*	*Number*
Brown, dark or light	Carton	1.00	1 cup	2.00	(1)	(1)
		25.00	do	50.00	(1)	(1)
Cubes	do	1.00	2 cubes	40.00	(2)	2½
	Bulk	25.00	do	1,000.00	(2)	(2)
Granulated:						
Bulk	Carton	1.00	2 level or 1 rounded teaspoon	54.00	(2)	2
			1 cup	2.25	(1)	(1)
	Bag	5.00	1 cup	11.25	(1)	(1)
	do	25.00	do	56.25	(1)	(1)
	Sack	100.00	do	225.00	(1)	(1)
Individuals	Package	1.50	1 packet	100.00	(2)	1
	Carton	45.00	do	3,000.00	(2)	(2)
Powdered (confectioners)	do	1.00	1 cup	3.50	(1)	(1)
	Sack	25.00	do	87.50	(1)	(1)
Sirup:						
Blends	12-fluid-ounce bottle	1.03	2 tablespoons	12.00	2¼	8½
	Quart	2.83	do	32.00	(2)	3¼
	No. 10 can	8.50	do	96.00	(2)	1¼
	Gallon	11.00	do	128.00	(2)	(2)
Corn	Pint	1.50	do	16.00	1¾	6¼
	5-pound can	5.00	do	53.33	(2)	2
	No. 10 can	8.79	2 tablespoons	93.76	(2)	1¼
			1 cup	11.72	(1)	(1)
Maple	Pint	1.38	2 tablespoons	16.00	1¾	6¼
	Gallon	11.00	do	128.00	(2)	(2)
Molasses	Pint	1.50	do	16.00	1¾	6¼
	Jar	2.00	do	21.00	1¼	5
	No. 10 can	9.31	do	99.00	(2)	1
Jam, jelly, marmalade:						
Bulk	Jar	1.00	1 tablespoon	23.00	1¼	4½
	No. 10 can	8.38	do	192.00	(2)	(2)
Individuals	Carton	----------	1 packet	200.00	(2)	(2)
Other sweets:						
Apple butter	Jar	1.00	do	11.00	2½	9¼
	No. 10 can	7.50	do	81.00	(2)	1¼
Honey	Jar	1.00	do	11.00	2½	9¼
	2-pound can	2.00	do	22.00	1¼	4¾
	5-pound can	5.00	do	54.00	(2)	2
Desserts, dry:						
Gelatin, flavored	3-ounce package	.19	½ cup	4.00	6¼	25
	6-ounce package	.38	do	8.00	3¼	12½
	Pound	1.00				

Chocolate	4-ounce package	.25	do	1.00	5¾	25
	Pound	1.00	4 ounces	20.00	1¼	5
			Fill for ⅙ 9-inch pie	18.67	1½	5½
Lemon chiffon	do	1.00	Fill for ⅙ 9-inch pie	32.00	(2)	3¼
Vanilla	3-ounce package	.19	½ cup	4.00	6¼	25
	Pound	1.00	4 ounces	25.60	1	4
			Fill for ⅙ 9-inch pie	24.00	1¼	4¼
Pudding, instant:						
Chocolate	4½-ounce package	.28	½ cup	4.00	6¼	25
	Pound	1.00	do	14.29	1¾	7
Vanilla	3¾-ounce package	.23	do	4.00	6¼	25
	Pound	1.00	do	17.39	1½	5¾

[1] Number of purchase units needed is determined by use.

[2] Number of purchase units needed is less than one.

Table 21.—BEVERAGES

Beverages as purchased	Unit of purchase	Weight per unit	Portion as served	Portions per purchase unit	Approximate purchase units [1] for—	
					25 portions	100 portions
		Pounds		*Number*	*Number*	*Number*
Carbonated drinks:						
6-ounce bottles	Case (24)		6 fluid ounces	24.00		
12-ounce bottles	do		do	48.00		
16-ounce bottles	do		do	64.00		
Cocoa:						
Regular, unsweetened	Pound	1.00	1 measuring cup, prepared	50.00	½	2
Instant, sweetened:						
Bulk	8-ounce carton	.50	1 cup	28.00	(1½ c.)	(6 c.).
	38-ounce carton	2.38	do	133.00	(1½ c.)	(6 c.).
Individuals	Carton (50)		1 packet	50.00	½	2
Sirup, sweetened	16-ounce can	1.00	1 cup	29.00	1	3½.
Coffee:						
Ground	Pound	1.00	1 measuring cup, prepared	[2] 37.00		
Instant:						
Bulk	6-ounce jar	.38	1 level teaspoon	180.00	(½ c.+1 t.)	(2 c.+4 t.).
			1 rounded teaspoon	90.00	(½ c.+1 t.)	(2 c.+4 t.).
	10-ounce jar	.62	1 level teaspoon	300.00	(½ c.+1 t.)	(2 c.+4 t.).
Individuals	Carton (72)		1 packet	72.00		
Tea:						
Bulk	Pound	1.00	1 measuring cup, prepared	256.00		(6¼ oz.).
Bags	Package (48)	.24	1 measuring cup or more	48.00		
	Carton (100)	.50	do	100.00	¼	1
Instant	1½-ounce jar	.09	1 cup hot tea	96.00	(½ c.+1 t.)	(2 c.+4 t.).
			1 cup iced tea	64.00	(¾ c.)	(3 c.).

[1] Numbers in parentheses refer to approximate measure to serve 25 and 100 portions: c., cup; t., teaspoon; oz., ounces.

[2] Varies depending on brand of coffee used and method of preparation.

OTHER USEFUL INFORMATION FOR ESTIMATING FOOD QUANTITIES

TABLE 22.—*Conversion factors for computing the number of purchase units needed for portions of vari sizes*

Portion size given in purchase tables (ounces)	Conversion factors for specified portion size, ounces									1(
	1	2	3	4	5	6	7	8	9	
1	1. 00	2. 00	3. 00	4. 00	5. 00	6. 00	7. 00	8. 00	9. 00	1(
2	. 50	1. 00	1. 50	2. 00	2. 50	3. 00	3. 50	4. 00	4. 50	5
3	. 33	. 67	1. 00	1. 33	1. 67	2. 00	2. 33	2. 67	3. 00	3
4	. 25	. 50	. 75	1. 00	1. 25	1. 50	1. 75	2. 00	2. 25	2
5	. 20	. 40	. 60	. 80	1. 00	1. 20	1. 40	1. 60	1. 80	2
6	. 17	. 33	. 50	. 67	. 83	1. 00	1. 17	1. 33	1. 50	1
7	. 14	. 29	. 43	. 57	. 71	. 86	1. 00	1. 14	1. 29	1
8	. 12	. 25	. 38	. 50	. 62	. 75	. 88	1. 00	1. 12	1

How To Use Table 22:

This table is to be used to help determine the number of purchase units if the size of portion is different from that specified in tables 1 to 21. For example, for 3-ounce portions of snap beans, five No. 10 cans are required (table 10); for other size portions, conversion factors in this table can be used to determine the number of No. 10 cans required.

The figures in the left-hand column of the conversion table represent the portion sizes given in tables 1 to 21. The figures across the top represent portion sizes that may be desired. If a 4-ounce instead of a 3-ounce portion of canned snap beans is to be used, for example, find 3-ounce line in the left-hand column of the conver table. Follow this line across to the factor in the 4-ou column. Multiply this factor (1.33) by the numbe purchase units (five No. 10 cans) given in table 10 100. Thus: 5 (No. 10 cans) × 1.33=6.65 No. 10 c (round to 6¾ No. 10 cans) to serve 100 people each ounce portion.

Portion sizes in the purchase tables are sometimes gi in terms of tablespoons, cups, slices, etc. Any of th measures can be substituted for ounces in this conversi table and the same computations performed.

TABLE 23.—*Cost per portion for food priced from 10 cents to $2 per purchase unit*

Price per purchase unit (cents)	Cost per portion for indicated portions per purchase unit							
	4	6	8	10	12	16	20	24
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
10	2. 5	1. 7	1. 2	1. 0	0. 8	0. 6	0. 5	(
15	3. 8	2. 5	1. 9	1. 5	1. 2	. 9	. 8	
20	5. 0	3. 3	2. 5	2. 0	1. 7	1. 2	1. 0	
25	6. 2	4. 2	3. 1	2. 5	2. 1	1. 6	1. 2	1
30	7. 5	5. 0	3. 8	3. 0	2. 5	1. 9	1. 5	1
35	8. 8	5. 8	4. 4	3. 5	2. 9	2. 2	1. 8	1
40	10. 0	6. 7	5. 0	4. 0	3. 3	2. 5	2. 0	1
45	11. 2	7. 5	5. 6	4. 5	3. 7	2. 8	2. 2	1
50	12. 5	8. 3	6. 2	5. 0	4. 2	3. 1	2. 5	2
60	15. 0	10. 0	7. 5	6. 0	5. 0	3. 8	3. 0	2
70	17. 5	11. 7	8. 8	7. 0	5. 8	4. 4	3. 5	2
80	20. 0	13. 3	10. 0	8. 0	6. 7	5. 0	4. 0	3
90	22. 5	15. 0	11. 2	9. 0	7. 5	5. 6	4. 5	3
100	25. 0	16. 7	12. 5	10. 0	8. 3	6. 2	5. 0	4
110	27. 5	18. 3	13. 8	11. 0	9. 2	6. 9	5. 5	4
120	30. 0	20. 0	15. 0	12. 0	10. 0	7. 5	6. 0	5
130	32. 5	21. 7	16. 2	13. 0	10. 8	8. 1	6. 5	5
140	35. 0	23. 3	17. 5	14. 0	11. 7	8. 8	7. 0	5
150	37. 5	25. 0	18. 8	15. 0	12. 5	9. 4	7. 5	6
160	40. 0	26. 7	20. 0	16. 0	13. 3	10. 0	8. 0	6
170	42. 5	28. 3	21. 2	17. 0	14. 2	10. 6	8. 5	7.
180	45. 0	30. 0	22. 5	18. 0	15. 0	11. 2	9. 0	7.
190	47. 5	31. 7	23. 8	19. 0	15. 8	11. 9	9. 5	7.
200	50. 0	33. 3	25. 0	20. 0	16. 7	12. 5	10. 0	8.

How To Use Table 23:

Determine the number of portions per unit of purchase through use of the food item or from the column, "Portions per purchase unit," in appropriate table. Locate the column in the table above that is nearest to that number. Then locate in that column the number horizo tal to the price paid for the purchase unit in the left-ha column. This number represents the approximate cost a portion.

BLE 24.—BEEF: *Approximate percentage of edible meat [1] from the carcass and wholesale cuts of Choice, Good, and Standard grades of beef*

[Steers ranging from 11 to 21 months in age]

Beef	Grade of carcass		
	Choice	Good	Standard
	Percent	*Percent*	*Percent*
rcass	85	84	82
olesale cuts:			
Brisket	88	87	85
Chuck	86	85	83
Flank	100	100	100
Foreshank	58	58	56
Loin end	89	88	86
Round, with hindshank	85	84	82
Rump, knuckle out	87	86	84
Short loin	90	89	87
Standing rib	85	83	80
Short plate	90	89	86

[1] The remaining percentage of beef consists of bone, ligament, and tendon.

BLE 25.—LAMB: *Approximate percentage of edible meat [1] from the carcass and wholesale cuts of Prime, Choice, and Good grades of lamb*

Lamb	Grade of carcass		
	Prime	Choice	Good
	Percent	*Percent*	*Percent*
rcass	86	83	82
olesale cuts:			
Breast and flank	89	86	86
Leg	87	85	84
Loin	90	87	86
Neck	79	75	75
Rib cut (9 ribs)	86	82	80
Shoulder (3 ribs)	87	85	84

[1] The remaining percentage of lamb consists of bone and ligament.

ABLE 26.—PORK: *Approximate percentage of edible meat [1] from the carcass and wholesale trimmed cuts from hogs of 3 weight groups*

Pork	Weight of carcass [2]		
	200 pounds live, 158 pounds dressed	225 pounds live, 178 pounds dressed	250 pounds live, 197 pounds dressed
	Percent	*Percent*	*Percent*
rcass	79	80	82
olesale cuts:			
Bacon	92	93	94
Ham	85	85	86
Head, full cut	47	50	53
Loin	78	79	79
Shoulder, full cut	84	85	86
Shoulder, ribs	40	42	45
Spareribs	58	61	63

The remaining percentage consists of bone and skin.

[2] The average yield of lard per hog slaughtered is 14 cent per 100 pounds live weight. This percentage includes lard and rendered pork fat, and excludes bacon and salt pork.

TABLE 27.—VEGETABLES OR FRUITS: *Approximate amount of canned and frozen product obtained from specified quantities of fresh vegetables and fruits*

Vegetables or fruits	Home canning methods		Commercial canning methods		Frozen		
	Fresh	Yield, canned	Fresh	Yield of #10 cans, canned	Fresh	Yield, frozen	Fruit-to-sugar ratio
		Quarts		*Number*		*Pounds*	
Vegetables:							
Asparagus	2½ to 4½ pounds	1	8 to 9 pounds	1			
	1 crate	7–12	1 crate	3–4	1 crate	15	
Beans, lima	3 to 5 pounds [1]	1	5 pounds [2]	1			
	1 bushel [1]	6–11	1 bushel [2]	6	1 bushel [2]	29	
Beans, snap	1½ to 2½ pounds	1	4 to 5 pounds	1			
	1 bushel	12–20	1 bushel	6–8	1 bushel	24	
Beets, without tops	2 to 3½ pounds	1	8 pounds	1			
	1 bushel	15–26	1 bushel	6–7			
Broccoli					1 crate	23	
Carrots, without tops	2 to 3 pounds	1	8 pounds	1			
	1 bushel	17–25	1 bushel	6–7	1 bushel	25	
Corn, sweet, in husks	3 to 6 pounds	[3] 1	17 to 18 pounds	[3] 1			
	1 bushel	[3] 6–12	1 bushel	[3] 2	1 bushel	[3] 8	
Okra	1½ pounds	1	7 pounds	1			
Peas, green	3 to 6 pounds [1]	1	4 to 5 pounds [2]	1			
	1 bushel [1]	5–10	1 bushel [2]	6–8	1 bushel [2]	27	
Pumpkin and winter squash	1½ to 3 pounds	1	17 to 18 pounds	1			
	1 bushel	17–33	1 bushel	3	1 bushel	32	
Spinach, other greens	2 to 6 pounds	1	8 pounds	1			
	1 bushel	3–10	1 bushel	2–3	1 bushel	10–11	
Sweetpotatoes	2 to 3 pounds	1	7 pounds	1			
	1 bushel	17–25	1 bushel	7			
Tomatoes	2½ to 3½ pounds	1	12 pounds	1			
	1 bushel	15–21	1 bushel	4–5			
Tomato catsup			19 pounds	1			
			1 bushel	2–3			
Tomato paste			40 to 41 pounds	1			
			1 bushel	1–2			
Tomato sauce			21 pounds	1			

Apples	2½ to 3 pounds	1	10 pounds	1			
	1 bushel	15–20	1 bushel	4–5	1 bushel	26–31	5 to 1
Berries, except strawberries	1½ to 3 pounds	1	5 pounds	1			
	1 crate	12–24	1 crate	7	1 crate	34	4 to 1
Cherries, sour	2 to 2½ pounds	1	7 pounds	1			
	1 bushel	22–28	1 bushel	8	1 bushel	53	4 to 1
Peaches	2 to 3 pounds	1	7 pounds	1			
	1 bushel	15–25	1 bushel	6–7	1 bushel	41–44	3 to 1
Pears	2 to 3 pounds	1	8 pounds	1			
	1 bushel	15–24	1 bushel	5–6			
Plums	1½ to 2½ pounds	1	5 pounds	1			
	1 bushel	19–32	1 bushel	9–10			
Strawberries	1½ to 3 pounds	1	6 pounds	1			
	1 crate	12–24	1 crate	6	1 crate	42	3 to 1

[1] In pods. [2] Shelled basis. [3] Whole kernel.

TABLE 28.—*Common can and jar sizes*

Container				Principal products
Can size (Industry term)	Consumer description			
	Average net weight or fluid measure per can [1] (check label)	Average cups per can	Cans per case	
		Number	*Number*	
8 ounces	8 ounces	1	48 and 72	Small cans—ready-to-serve soups, fruits, and vegetables.
No. 1 picnic	10½ to 12 ounces	1¼	48	Small cans—condensed soups, some fruits, vegetables, meat, and fish.
No. 300	14 to 16 ounces	1¾	24	Small cans—fruits, vegetables, some meat and poultry products, and ready-to-serve soups.
No. 303	16 to 17 ounces	2	24	Do.
No. 2	1 pound, 4 ounces (20 ounces) or 1 pint, 2 fluid ounces (18 fluid ounces).	2½	24	Family size—juices, ready-to-serve soups, and some fruits.
No. 2½	1 pound, 13 ounces (29 ounces)	3½	24	Family size—fruits and some vegetables.
No. 3 cylinder	3 pounds, 3 ounces (51 ounces) or 1 quart, 14 fluid ounces (46 fluid ounces).	5¾	12	"Economy family size"—fruit and vegetable juices. Institutional size—condensed soups, some vegetables, and meat and poultry products.
No. 10	6 pounds, 8 ounces (104 ounces) to 7 pounds, 5 ounces (117 ounces).	12 to 13	6	Institutional size—fruits, vegetables and some other foods.

[1] The label on one product may show net weight that differs slightly from the label on another product in cans or jars of identical size. (An example would be lima beans (1 pound) and blueberries (14 ounces) in the same si can.)

Source: National Canners Association.

Ounce equivalents in decimal parts of pound

Ounces	*Pound*	*Ounces*	*Pou*
1	0. 06	9	.
2	. 12	10	.
3	. 19	11	.
4	. 25	12	.
5	. 31	13	.
6	. 38	14	.
7	. 44	15	.
8	. 50	16	1.

Approximate scoop equivalents

Scoop No.[1]	*Level measure*	*Scoop No.*[1]	*Level measu*
6	⅔ cup	20	3⅕ tablespoo
8	½ cup	24	2⅔ tablespoo
10	⅖ cup	30	2⅕ tablespoo
12	⅓ cup	40	1⅗ tablespoo
16	¼ cup		

[1] A serving spoon may be used to replace a scoop. Since serving spoons are not identified by number, it is necessary to measure or weigh the quantity of food from sizes of spoons used to obtain the approximate serving siz desired.

Common food-measure equivalents

3 teaspoons	1 tablespoon	16 tablespoons	1 cup
2 tablespoons	1 fluid ounce	1 cup	8 fluid ounces
4 tablespoons	¼ cup	2 cups	1 pint
6 tablespoons	⅜ cup	2 pints	1 quart
8 tablespoons	½ cup		

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low to cook clams. USDI Test Kitchen Series 8, 14 pp. 1953.
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'resh and frozen fish buying manual. USDI Circular 20, 50 pp. 1954.
hopper's guide to U.S. grades for food. USDA Home and Garden Bulletin No. 58, 13 pp. (Slightly rev. 1964.)

[1] Publications indicated for sale may be obtained only om the Superintendent of Documents, U.S. Government rinting Office, Washington, D.C., 20402; USDI publicaons may be obtained from the Bureau of Commercial isheries, U.S. Department of the Interior, Washington, .C., 20240; USDA publications may be obtained from ıe Office of Information, U.S. Department of Agriculture, Vashington, D.C., 20250.

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Fish cookery for one hundred. USDI Test Kitchen Series 1, 44 pp. 1950.
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Food buying guide for type A school lunches. USDA Program Aid 270, 75 pp. 1964. $1.25.
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Recipes for quantity service. USDA Home Economics Research Report No. 5, 225 pp. 1958. $2.50.

INDEX OF FOODS IN TABLES 1 THROUGH 21

	Page
monds	17
pple butter, canned	42
pple juice, canned	32
pples:	
canned	32
dried	36
fresh	29
frozen	34
pplesauce:	
canned	32
dried	36
pricots:	
canned	32
dried	36
fresh	29
frozen	34
sparagus:	
canned	23
fresh	20
frozen	26
vocados, fresh	29
acon	5
ananas, fresh	29
eans, butter (lima) frozen	26
eans, dried:	
canned	23
raw	28
eans, lima, green:	
canned	23
fresh	20
frozen	26
eans, snap, green or wax:	
canned	23
fresh	20
frozen	26
ean sprouts, canned	23
eans with frankfurters in sauce, canned	8
eans with ham in sauce, canned	8
eans with meat in chili sauce, canned	8
eef:	
canned	5
dried	5
fresh or frozen	3
eef goulash:	
canned	8
frozen	8
eef stew, canned	8
eef with barbecue sauce, canned	8
eef with gravy, canned	8
eet greens, fresh	20
eets:	
canned	23
fresh	20
scuit mix	39
ackberries:	
canned	32
fresh	29
frozen	34
ackeye peas:	
fresh	20
frozen	26
lueberries:	
canned	32
fresh	29
frozen	34
oysenberries, canned	32
Bran flakes	38
Bran flakes with raisins	38
Brazil nuts	17
Bread	40
Broccoli:	
fresh	20
frozen	26
Brunswick stew, canned	8
Brussel sprouts:	
fresh	20
frozen	26
Bulgar, cracked wheat	37
Butter	41
Cabbage, Chinese, fresh	20
Cabbage, fresh	20
Cake:	
mixes	38
ready-to-eat	40
Canadian bacon	5
Cantaloup, fresh	29
Carbonated drinks	43
Carrots:	
canned	23
fresh	20
frozen	26
Cashew nuts	17
Cauliflower:	
fresh	20
frozen	26
Celery, fresh	20
Cereals:	
ready-to-eat	38
uncooked	37
Chard, fresh	20
Cheese:	
cheddar	18
cottage	18
cream	18
processed	18
Cherries:	
canned	32
fresh	29
frozen	34
Chestnuts	17
Chicken:	
canned	10
fresh or frozen	10
Chicken combinations, canned or frozen:	
a la king	12
burgers	12
cacciatore	12
chop suey	12
chow mein	12
creamed	12
fricassee	12
minced, barbecue	12
noodles or dumplings	12
potpie	12
sliced with gravy	12
stew	12
tamales	12
Chicken parts, fresh or frozen	10
Chicory	21
Chili con carne, canned	8
Chili con carne with beans, canned	8
Chili mac, canned	8

	Page
Chop suey or chow mein vegetables with meat:	
canned	9
frozen	9
Chop suey vegetables, canned	23
Clam chowder	14
Clam juice	14
Clams:	
fresh (live in shell)	14
fresh or frozen, shucked	15
frozen, breaded	15
minced	14
Cocoa	43
Coconut	17
Cod, dried	13
Coffee	43
Collards:	
canned	23
fresh	20
frozen	26
Cookies:	
mixes	39
ready-to-eat	40
Corn:	
canned	23
fresh	20
frozen	26
Corn flakes	38
Corn grits	37
Cornmeal	37
Crabcakes, frozen	15
Crabmeat:	
canned	14
fresh or frozen	15
Crabs:	
fresh (live in shell)	14
fresh or frozen (cooked in shell)	15
Crackers	40
Cranberries:	
canned	32
fresh	29
Cranberry juice	32
Cream	18
Cucumbers, fresh	21
Dates, dried	36
Desserts, dry	42
Duck, fresh or frozen	11
Eggplant	21
Eggs	16
Endive	21
Escarole	21
Farina	37
Figs:	
canned	32
fresh	29
Filberts	17
Fish:	
canned	13
dried	13
fresh or frozen:	
drawn	13
dressed	13
fillets	13
steaks	13
whole or round	13
Fish (portions), frozen:	
breaded	14
unbreaded	14
Fish sticks, breaded	14
Flour	37
Frankfurters	7
Frosting mixes	38
Fruit cocktail or salad:	
canned	33
dried	36
Fruit juices. (*See* specific kind.)	
Gefiltefish, canned	13
Gelatin, flavored	
Goose, fresh or frozen	
Grapefruit:	
canned sections	
fresh	
fresh segments	
frozen sections	
Grapefruit juice:	
canned	
frozen concentrate	
Grape juice, frozen concentrate	
Grapes, fresh	
Hash, beef, canned	
Honey	
Honeydew melon	
Hot bread mixes	
Ice cream	
Jam	
Jelly	
Kale:	
canned	
fresh	
frozen	
Kohlrabi, fresh	
Lamb, fresh or frozen	
Lamb stew, canned	
Lard	
Lemonade, frozen concentrate	
Lemon juice:	
canned	
frozen concentrate	
Lemons, fresh	
Lentils	
Lettuce	
Lime juice, canned	
Limes, fresh	
Lobster, fresh or frozen (cooked in shell)	
Lobster meat, fresh or frozen	
Lobster, spiny tails, frozen	
Luncheon meats (all meat varieties)	
Macaroni	
Macaroni and beef in tomato sauce, canned	
Mackerel, canned	
Mangoes	
Margarine	
Marmalade	
Meatballs with gravy:	
canned	
frozen	
Melon, honeydew	
Melon scoops, frozen	
Milk	
Mixes:	
cake	
cookie	
frosting	
hot bread	
piecrust	
Molasses	
Muffin mix	
Mushrooms:	
canned	
fresh	
Mustard greens:	
canned	
fresh	
frozen	
Noodles	
Noodles with chicken, canned	
Nuts	
Oats, rolled	
Okra:	
canned	
fresh	
frozen	

	Page
ıd tomatoes, canned	23
canned	24
ıned	24
ed	28
sh:	
green	21
mature	21
juice:	
ıned	33
zen concentrate	35
s:	
sh	30
sh segments	30
ndarin, canned	33
:	
ıned	14
sh (live in shell)	15
sh or frozen, shucked	15
zen, breaded	15
stew	14
	21
s	21
s:	
ıned	33
ed	36
sh	30
zen	35
ced	33
butter	17
s	17
ıned	33
sh	30
ried	28
reen:	
ıned	24
sh	21
zen	27
ıd carrots:	
ıned	24
zen	27
	17
s, green:	
sh	21
zen	27
relish	24
	24
ıdy-to-eat	41
t mix	39
ng, fruit. (*See* appropriate fruit.)	
ng, mix	43
tos, canned	24
ple:	
ıned	33
sh	31
zen	35
ple juice:	
ıned	33
zen concentrate	35
ıned	33
sh	31
ıned	6
red	5
sh	6
ith barbecue sauce:	
ıned	9
waxed tub	9
ith gravy, canned	9
es:	
ıned	24
ied	28

	Page
Potatoes—Continued	
fresh	21
frozen	27
Prunes:	
canned	33
dried	36
Pudding, instant mix	43
Pudding mix	43
Pumpkin:	
canned	24
fresh	22
Radishes	22
Raisins	36
Raspberries:	
canned	33
fresh	31
frozen	35
Ravioli with meat in sauce, canned	9
Rhubarb:	
fresh	31
frozen	35
Rice	37
Rice, puffed	38
Rice flakes	38
Rolls:	
mix	39
ready-to-eat	41
Rutabagas, fresh	22
Salad dressing	41
Salad oil	41
Salmon, canned	13
Sardines, canned:	
Maine	13
Pacific	13
Sauerkraut, canned	24
Sausage	6
Scallops:	
fresh or frozen, shucked	15
frozen, breaded	15
Sherbet	19
Shortening	41
Shrimp:	
canned	14
fresh or frozen (cooked and raw)	15
frozen, breaded	15
Sirup:	
blends	42
corn	42
maple	42
Soups:	
canned	25
condensed	25
ready-to-serve	25
Spaghetti	37
Spaghetti with meatballs and sauce, canned	9
Spinach:	
canned	25
fresh	22
frozen	27
Split peas	28
Squash, summer:	
canned	25
fresh	22
frozen	27
Squash, winter:	
canned	25
fresh	22
frozen	27
Strawberries:	
canned	33
fresh	31
frozen	35
Succotash:	
canned	25
frozen	27
Sugar	42

	Page
Sweetpotatoes:	
canned	25
dried	28
fresh	22
frozen	27
Tamales, frozen	9
Tamales with gravy or sauce, canned	9
Tangerine juice, frozen concentrate	35
Tangerines, fresh	31
Tea	43
Tomatoes:	
canned	25
fresh	22
Tomato products:	
catsup	25
chili sauce	25
juice, concentrate	25
Tuna, canned	13
Turkey:	
canned	11
fresh or frozen	11
stuffed, whole, frozen	11
Turkey combinations, canned or frozen:	
a la king	12
creamed	12
fricassee	12
Turkey etc.—Continued	
potpie	
sliced with gravy	
Turkey parts, fresh or frozen	
Turkey rolls, frozen	
Turnip greens:	
canned	
fresh	
frozen	
Turnip greens with turnips, frozen	
Turnips, fresh	
Veal, fresh or frozen	
Vegetable juices, canned	
Vegetables, mixed:	
canned	
frozen	
Vienna sausage	
Walnuts	
Watercress, fresh	
Watermelon, fresh	
Wheat:	
flakes	
puffed	
puffed, presweetened	
rolled	
shredded	
whole	

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DRY BEAN PRODUCTION

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CONTENTS

	Page
Centers of dry bean production	3
Limiting factors in bean production	5
Importance of good seed	7
Seed sources	8
Bean types and varieties	11
Pea, or Navy	11
Kidney	15
Yellow Eye	16
Miscellaneous	16
Soil types	17
Crop rotation	17
Soil preparation	19
Fertilization	20
Inoculation	22
Planting	22
Cultivation	23
Chemical weed control	24
Harvesting	25
Defoliation	28
Production costs	28
Marketing, cleaning, and grading	29
Diseases	31
Insects	32

This handbook contains information of the type formerly published in Farmers' Bulletin 2083, "Dry Bean Production in the Eastern States."

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DRY BEAN PRODUCTION

in the Lake and Northeastern States

By Axel L. Andersen, *Crops Research Division, Agricultural Research Service* [1]

Dry beans are an important item in the diet of the American people. They are relatively inexpensive and highly nutritious, being high in protein (20 to 25 percent), phosphorous, iron, and vitamin B_1. In the United States, nearly 20 million 100-pound bags are produced annually, and annual consumption is approximately 8 pounds for every man, woman, and child.

CENTERS OF DRY BEAN PRODUCTION

Nearly half the dry beans produced in the United States come from central Michigan and western New York (figs. 1 and 2). A small quantity is produced in central Maine and in neighboring States.[2] The remainder is produced in the Western States.

Dry beans are very important as a cash crop. The Michigan crop is valued at over $50 million annually. The New York crop is valued at nearly $10 million and the Maine crop at slightly less than $1 million.

Dry bean production is expected to increase to supply the domestic and foreign markets.

It has increased markedly in Michigan but decreased slightly in New York and Maine. Of the 9 million bags produced in 1963 in the three States, Michigan produced 86 percent, New York 13.5 percent, and Maine 0.5 percent.

Data on dry bean production for Michigan (table 1) and New York (table 2) from 1957 through 1963 have been summarized to illustrate the production trends and the importance of the industry in the economy of the two States. Data by varieties are given in table 3.

Michigan produces over 99 percent of all the Pea (Navy) beans [3] grown annually in the United States. Of all the Pea beans sold in the United States for domestic consumption, 85 percent are sold in cans.

---

[1] The author gratefully acknowledges the assistance and suggestions provided by specialists at the Maine, Michigan, and New York Agricultural Experiment Stations and in various agencies of the U.S. Department of Agriculture and State departments of agriculture.

[2] The central Maine area includes parts of Kennebec, Penobscot, Piscataquis, and Waldo Counties. Each county harvested less than 500 acres in 1959.

[3] In Michigan the Pea bean is commonly referred to as the Navy bean.

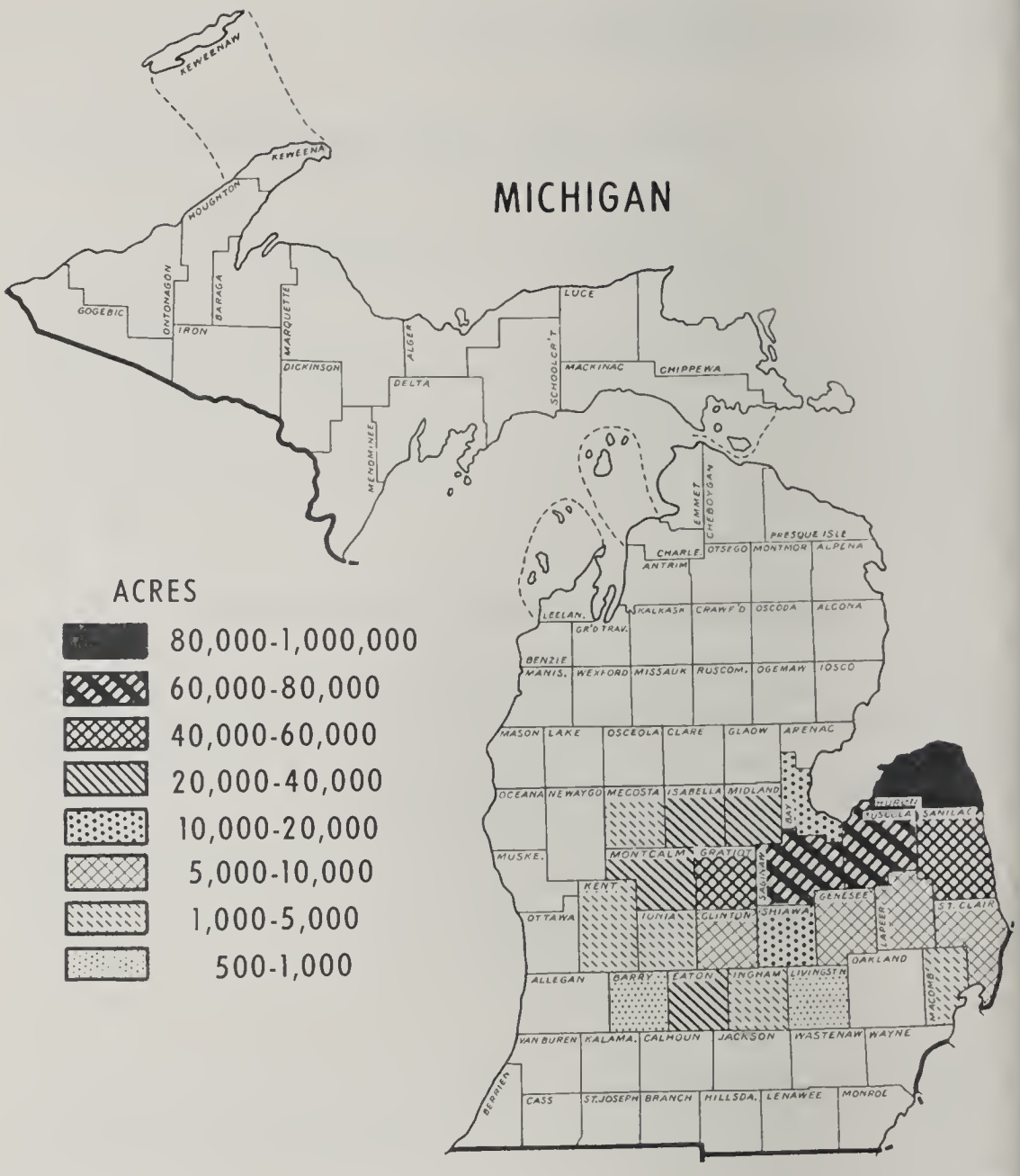


FIGURE 1.—Counties in Michigan with more than 500 acres of dry beans. Data obtained from the 1960 U.S. Census of Agriculture.

The industry in Michigan is geared to serve the canning trade, not only in the United States but in the foreign market as well. In 1963, over 200 million pounds of Pea beans were exported, mostly for canning.

Michigan-grown Dark Red and Light Red Kidney beans are sold for both the dry package and the canning trade. Yellow Eye, Cranberry, Pinto, and other beans are sold in the dry package form.

Only 50 percent of the Red Kidney beans produced in New York are canned. From 5 to 15 percent are exported, and the remainder are sold in dry packages. Nearly all the Black Turtle Soup beans are sold for export. A few are canned and sold as packaged beans. Other New York varieties are sold mainly as dry beans.

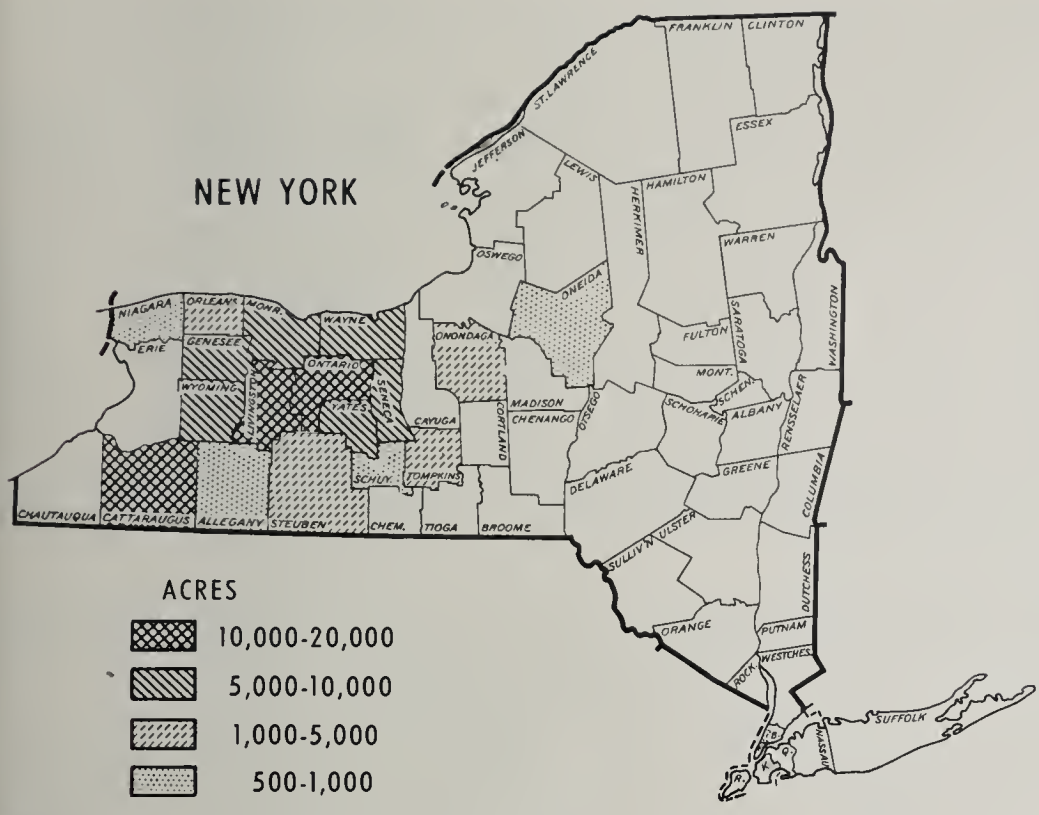


FIGURE 2.—Counties in New York with more than 500 acres of dry beans. Data obtained from the 1960 U.S. Census of Agriculture.

LIMITING FACTORS IN BEAN PRODUCTION

Bean prices, like the prices of other agricultural commodities, vary from season to season. Varieties that are under Government price supports tend to fluctuate less in price, except when the supply is low. Varieties of minor importance, such as Black Turtle Soup, Cranberry, White Kidney, White Marrow, and Yellow Eye, have limited markets and are not included under the Government price support program. Hence, their prices fluctuate considerably from year to year.

TABLE 1.—*Acreage, yield, production, and value of dry beans in Michigan, 1957–63* [1]

Year	Acres harvested	Yield per acre	Production [2]	Value of production
	1,000 acres	*Pounds*	*1,000 bags*	*1,000 dollars*
1957	474	740	3,508	27,012
1958	536	975	5,226	33,969
1959	509	1,260	6,413	35,913
1960	525	1,190	6,248	36,963
1961	541	1,360	7,358	47,091
1962	573	1,290	7,392	47,420
1963	573	1,480	8,480	51,000

[1] Source: Michigan Agricultural Statistics Reporting Service.
[2] Bags of 100 pounds.

TABLE 2.—*Acreage, yield, production, and value of dry beans in New York, 1957–63* [1]

Year	Acres harvested	Yield per acre	Production [2]	Value of production
	1,000 acres	*Pounds*	*1,000 bags*	*1,000 dollars*
1957	104	1, 120	1, 165	8, 932
1958	114	1, 150	1, 311	9, 541
1959	89	940	837	9, 746
1960	96	1, 270	1, 219	8, 777
1961	87	1, 530	1, 331	10, 070
1962	98	1, 300	1, 274	8, 876
1963	82	1, 200	984	9, 530

[1] Source: Statistical Reporting Service, New York Crop Reporting Service, Albany, N.Y.
[2] Bags of 100 pounds.

TABLE 3.—*Dry bean production by varieties for Michigan and New York, 1962–63* [1]

Variety	Michigan		New York	
	1962	1963	1962	1963
	1,000 bags [2]	*1,000 bags* [2]	*1,000 bags* [2]	*1,000 bags* [2]
Pea (Navy)	6, 696	7, 480	30	41
Red Kidney [3]	460	700	884	785
Cranberry	75	100	----------	----------
Yellow Eye	70	80	9	12
Pinto	70	95	----------	----------
White Marrow	----------	----------	23	26
Black Turtle Soup	----------	----------	317	99
Other	21	25	11	21
Total	7, 392	8, 480	1, 247	984

[1] Source: Michigan Agricultural Statistics Reporting Service, Lansing, Mich.
[2] In 100-pound bags; cleaned basis.
[3] The New York production was mainly Light Red Kidney beans. Michigan production consisted of 340,000 bags of Dark Red Kidney beans and 120,000 bags of Light Red Kidney beans in 1962; and 500,000 Dark Red Kidney and 200,000 Light Red Kidney beans in 1963.

The first factor for the prospective grower to consider is the availability of a bean elevator in the locality for handling and marketing his beans. The next consideration is the type of bean to grow. This will be determined by market preference and the ability of the dealer to handle the beans. Many elevators are equipped to handle only one or two types of beans.

All bean types are not in direct competition with each other. Pinto beans, for instance, are preferred by people of Mexican descent; most Yellow Eye beans are marketed in the New England and South Atlantic States; Cranberry beans are preferred in the Southeast; and Red Kidney beans are used mainly for canning.

Quality is more important than ever because of the competition among types of beans. Great Northern and Pea beans compete in the dry packaging trade throughout the country, but the canning trade prefers the Pea bean because of its canning qualities. Since quality is a major factor and since disease and weather conditions influence quality, the susceptibility of varieties to disease and climate must be considered in producing dry beans in the Lake and Northeastern States.

Bean weevil infestations, precipitation, and the occurrence of hot, dry winds during the flowering season determine the southern limits of production. Length of the frost-free growing season determines the northern limits. Because dry beans are a comparatively short season crop, they are especially adapted to areas where the frost-free growing season is from 105 to 120 days.

Extensive droughts during the growing season, and especially during pod-setting time, can lower the yields considerably. Cool, wet seasons are also highly unfavorable, because beans are easily injured by excessive moisture and are subject to attack by diseases that thrive under these conditions. Hot, dry winds during blossoming may cause severe blossom drop and hence lower the yield considerably, or they cause nonuniform ripening of the crop. Plants that lose many of their first blossom generally set more blooms a week or 10 days later. Beans are killed by freezing; however, they are adapted to a fairly wide temperature range. Temperatures between 65° and 75° F. are the most favorable for bean growing.

Soil types, drainage, crop sequence, and the availability of equipment for growing and harvesting the crop are other factors to be considered.

Anyone interested in the production of dry beans should consult his county agricultural agent. Additional information may be obtained from Extension Service specialists and State agricultural experiment stations, as well as from industry representatives. Dates of planting, rates of seeding, fertilizers, crop rotations, and varieties recommended will vary considerably within an area.

IMPORTANCE OF GOOD SEED

Probably the most critical item in the production of dry beans is the quality of the seed. A number of important diseases can be carried in or on the seed. These diseases are often responsible for the low yield and poor quality in beans sold.

Also, mechanical injury, frost damage, and wet weather damage at harvesttime prevent good germination of seed. Seed damaged by rough handling during harvest or subsequent processing results in retarded, nonvigorous, stunted, or baldheaded plants. Electric-eye sorters remove discolored beans, but not those that have been damaged mechanically (cracked seedcoats and broken cotyledons).

Many bean growers make the mistake of buying noncertified seed, because it is cheaper than certified seed. Noncertified seed may look clean, but it may be carrying bacterial blight or the bean common mosaic virus internally. The seed may also be carrying some anthracnose infection. It would be almost impossible to detect 20 or 30 anthracnose-infected beans in a 100-pound bag of beans. If distributed uniformly throughout the field at planting time, the infected beans would serve as a source of infection for the other beans in the field. This could result in heavy crop loss if wet, humid weather should occur during the growing season. The few extra dollars spent for certified seed is one of the best investments that can be made to insure a high-quality crop of better than average yield.

SEED SOURCES

Some of the dry bean seed used in the Lake and Northeastern States comes from the arid regions of California and Idaho and the remainder is produced locally. States in which certified seed of the principal dry bean types and varieties is grown are indicated in table 4. All certified seed has passed inspection for disease freedom, quality, germination, and varietal purity by the seed-certifying agency in the State in which it was produced. Specifications for certification vary with the different States, but the standards are high in all States: thus good-quality seed at the lowest possible cost is assured.

In Michigan, where bacterial blight is present and the annual requirements for Pea bean seed alone is over 20 million pounds, bean growers have to rely on locally produced seed. By following the recommended cultural practices for disease control as outlined on page 31, Michigan seed producers have been able to supply growers with certified Pea bean seed that is relatively free from bacterial blight and other seedborne diseases. This has been accomplished by contracting for the production of breeders seed in Idaho. The Idaho-grown seed, in turn, is planted for foundation seed in the upper part of the lower peninsula of Michigan, in an area away from the principal bean-producing areas in Michigan. The foundation seed fields are thoroughly inspected for the presence of seedborne diseases and for varietal purity. The following year the foundation seed is distributed to certified seed producers throughout the bean area of Michigan. Before harvest, the prospective certified-seed fields are inspected by the Michigan Crop Improvement Association, the seed-certifying agency in Michigan. If acceptable in the field, samples of the cleaned seed must be inspected in the Crop Improvement Laboratory to be certain the seed meets all the other requirements for certification.

A similar procedure is used for the production of certified Charlevoix Dark Red Kidney seed (figs. 3 and 4), but restrictions are greater as to the areas in which certified seed can be grown. Only seed fields of the Charlevoix variety located north of an east-west line running

TABLE 4.—*Principal types and commercial varieties of dry beans grown in the Lake and Northeastern States, resistance or susceptibility to certain diseases, and States in which certified seed is grown*

Type and variety	Common seedborne diseases [1]								State in which certified seed is grown
	Anthracnose strains			Bacterial blights		Mosaic [2]			
	Alpha	Beta	Gamma	Common and Fuscous	Halo (Race)	BCM–1	BCM–15	BCM–123	
Pea, or Navy									
Sanilac	R	R	R	S	MR	R	S	R	Michigan and New York.
Seaway	S	R	R	S	MR	R	R	R	Michigan.
Gratiot	R	R	R	S	MR	R	R	R	Michigan.
Michelite	S	R	R	S	MR	R–S	R	R–S	
Michelite-62	S	R	R	S	R	R	S	R	Michigan and New York.
Saginaw	R	R	R	S	MR	R	R	R	Michigan.
Kidney									
California Light Red Kidney.	R	S	S	S	S	S	S	S	California and Idaho.
Michigan Dark Red Kidney.	R	S	S	S	S	S	S	S	California and Idaho.
California Dark Red Kidney.	R	S	S	S	S	S	S	S	California.
Charlevoix	R	R	S	S	S	S	S	S	Michigan.
California White.	R	S	S	S	S	S	S	S	California.
Yellow Eye									
New York or Michigan Yellow Eye.	R–S	S	S	S	S	S	S	S	[3].
Steuben Yellow Eye.	R	S	S	S	S	S	S	S	New York.
New England Yellow Eye.	R	S	S	S	S	S	S	S	[3].
Miscellaneous									
Black Turtle Soup.	S	R	R	S	S	R	S	S	[3].
Perry Marrow	R	R	S	S	S	S	S	S	New York.
Michigan Cranberry.	R	S	S	S	S	S	S	S	California and Idaho.

[1] S=susceptible; R=resistant; MR=moderately resistant.

[2] Three strains of bean common mosaic attack beans. BCM–15, or Burkholder's strain, attacks varieties resistant to the common BCM–1 and BCM–123 strains of the virus.

[3] Seed of this variety not certified.

BN 23779

FIGURE 3.—Charlevoix (breeders seed) increase field in Magic Valley near Twin Falls, Idaho. The environmental conditions in this and certain other areas make it possible to produce bean seed comparatively free from bacterial blight.

BN 23780

FIGURE 4.—Charlevoix foundation seed field planted in northern lower Michigan from breeders seed produced in Idaho.

through Clare County, Mich., are acceptable for certification. However, Charlevoix beans grown north of this line in Huron County are not eligible for certification.

In New York the official seed-certifying agency for dry beans is the "New York Certified Seed Growers Cooperative, Incorporated." This organization is comparable to the Michigan Crop Improvement Association, the official seed-certifying agency in Michigan. In Michigan and New York seed standards are developed cooperatively by those agencies concerned with certification. These include the colleges of agriculture and the agricultural experiment stations at the respective universities, the State seed laboratories, and the State departments of agriculture.

BEAN TYPES AND VARIETIES

Dry beans vary in shape, size, and color. Figure 5 shows the more important types grown in the Lake and Northeastern States.

The Pea (Navy) bean is the most economically important type grown in Michigan. Over 7 million 100-pound bags were produced in 1963. This was over 99 percent of the Pea beans produced in the United States. Michigan also produces about 85 percent of Yellow Eye and 98 percent of Cranberry beans.

Western New York leads in the production of Red Kidney beans. That variety accounts for 75 percent of New York bean production. The Black Turtle Soup variety accounts for another 20 percent. Small quantities of Pea, White Kidney, Yellow Eye, and White Marrow are produced.

Yellow Eye is the most economically important bean grown in Maine.

Other bean varieties occasionally grown in limited quantities in the Lake and Northeastern States are Red Mexican, California Pink, Jacobs Cattle, and Soldier. The last two varieties are grown in Maine.

Table 4 lists the principal types and varieties of beans grown in Michigan, New York, and Maine, the diseases to which they are resistant, and the States in which certified seed is grown.

Pea, or Navy

All the Pea bean varieties grown for commercial production except Michelite were developed and released through cooperative arrangement between the Michigan State University Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture.

Bush types

Bush-type Pea bean varieties have several characteristics in common. They are upright and produce large numbers of flowers over an ex-

tended period. The flowers are produced at the ends of determinant branches set high on the plant, so the pods are well off the ground at maturity. The seed is white, round, and uniform. "Screenings" are considerably less from the bush-type than from the vine-type beans, because small beans are generally associated with nonuniform ripening of beans on a vine and the presence of Sclerotinia wilt (white mold), which kills the beans prematurely. The number of beans discolored

BN 23781

FIGURE 5.—Principal dry bean types grown in eastern United States: *A*, Light Red Kidney; *B*, Pea (Navy); *C*, Yellow Eye (New England type); *D*, Cranberry; *E*, Dark Red Kidney; *F*, White Kidney; *G*, Marrow; and *H*, Yellow Eye (New York or Michigan type).

BN 23782

FIGURE 6.—Field of Sanilac beans in Bay County, Mich. Note the uprightness of plants and the location of the flowers. This is characteristic of all bush-type varieties derived from an X-ray mutant bean.

by fungal growth is also much lower in bush-type beans because they can normally be pulled and threshed the same day. Vine-type beans, on the other hand, normally have to be pulled at least 1 day before threshing and are more subject to damage while in the windrow.

The bush-type Pea beans normally escape serious damage from white mold or Sclerotinia wilt except during seasons of very high relative humidities. The reason is that the foliage does not ordinarily form a canopy over the row, as does the foliage of vine-type beans. The improved aeration between the rows and around the plants lowers the relative humidity and creates an environment less favorable for infection and development of the fungus.

The history of the varietal development is also similar. Thus the Sanilac and Seaway varieties were developed concurrently in a back-crossing program in which the recurrent parents were selections obtained from a cross between a small, early maturing, bush-type mutant bean (obtained by treating Michelite seed with X-ray) and the Michelite variety. The Gratiot variety is a selection from a cross between Sanilac and a bush selection similar to Seaway.

Sanilac.—Sanilac [4] (fig. 6) is a high-yielding, upright, midseason bush bean released in 1956. The plants vary from 14 to 21 inches in height and produce short determinant runners up to 14 inches in length. The variety blooms in approximately 42 days and matures in about 88 days. It is resistant to the alpha, beta, and gamma races of the fungus that causes anthracnose and to bean common mosaic virus

[4] Cover photo shows harvesting of a field of certified Sanilac beans near Saginaw, Mich.

races 1 and 123 (BCM–1 and BCM–123). Sanilac is susceptible to BCM–15. It has field resistance to halo blight but it is susceptible to common and fuscous bacterial blights.

Sanilac is an F_4BC_2 selection from a three-way cross in which a bush-type mutant was the principal recurrent parent. Other bean materials involved in the cross include a selection from Robust X Crawford, Emerson 847, and Emerson 53.

Seaway.—Seaway (fig. 7) is a high-yielding, upright, short-season bush bean released in 1960. The plants vary from 13 to 19 inches in height. Unlike Sanilac, no short determinant runners are produced. The variety blooms in about 39 days and matures in about 79 days.

Seaway is resistant to bean common mosaic virus races 1, 15, and 123, but is susceptible to the alpha race of the fungus that causes anthracnose. It has field resistance to halo blight.

Seaway is an F_4BC_4 selection from a cross in which a bush-type mutant Pea bean developed by X-ray was a recurrent parent in a backcrossing program. Topcrop, a mosaic-resistant snap bean with the dominant or Corbett Refugee type resistance to bean common mosaic, was used as the initial parent to procure resistance.

BN 23783

FIGURE 7.—Field of Seaway beans in Tuscola County, Mich., planted in 38-inch rows. Plants are approximately 8 weeks old.

Gratiot.—Gratiot is a high-yielding, upright, midseason bush bean released in 1962. It resembles Sanilac in most of its characteristics but has certain improvements. For example, it is the first bush-type bean that successfully combines resistance to two major bean diseases—anthracnose and mosaic. In addition, it has superior growth habit and canning quality.

Gratiot is a sixth generation from a cross between Sanilac (anthracnose resistant) and a high-yielding, mosaic-resistant, stiff-strawed, upright bush selection with excellent canning quality. It is resistant to the alpha, beta, and gamma races of the fungus that causes anthracnose and to bean common mosaic virus races 1, 15, and 123. It is also resistant to halo blight.

Vine types

Michelite.—Michelite is a late-maturing bean that is grown in limited quantities in New York and Michigan. It is only partly resistant to bean common mosaic virus 1 (BCM–1). It is less tolerant to diseases that attack Pea beans than are any of the varieties described earlier. In the Michigan Seed Certification program, it has been replaced with Michelite-62.

Michelite–62.—Michelite–62 is a uniform-maturing, full-season bean selected from the old Michelite variety and released in 1961. It is fully resistant to bean common mosaic virus races 1 and 123 but is susceptible to race 15. It is susceptible to anthracnose but is fairly tolerant to common bacterial blight. It has field resistance to halo blight.

Saginaw.—Saginaw is a high-yielding, disease-resistant, midseason, vine-type bean released in 1961. This variety matures 4 or 5 days earlier than does Michelite–62 and has excellent canning qualities. The plants stand up well and hold the pods well off the ground. The thin-walled pods thresh easily.

Saginaw is a selection from a cross involving two other plant selections, one with anthracnose resistance and the other with bean common mosaic resistance. Hence, it is fully resistant to two major bean diseases. In addition, it is capable of producing a crop of beans on soils with low quantities of available zinc (see discussion of zinc deficiency, p. 20).

Kidney

California Light Red Kidney (Red Kidney 7811).—California Light Red Kidney was introduced in 1937 by the California Agricultural Experiment Station. It was developed from a cross between Nagazura and Red Kidney backcrossed to Red Kidney.

Michigan Dark Red Kidney.—Michigan Dark Red Kidney is an old variety commonly grown in Michigan. Because it is very susceptible to bacterial blight and anthracnose, planting western-grown seed is recommended.

California Dark Red Kidney.—California Dark Red Kidney was developed and released by the California Agricultural Experiment Station. It is a selection from a cross between Michigan Dark Red Kidney and Maui.

Charlevoix.—Charlevoix (figs. 3 and 4) is an upright, dark red kidney bean with long slender pods. It was developed by the Michigan State University Agricultural Experiment Station and the U.S. Department of Agriculture and was released in 1960. In Michigan this variety matures 7 to 14 days earlier than California Dark Red Kidney. It is resistant to the beta race of fungus that causes anthracnose in Red Kidney beans, a disease that formerly caused heavy losses to Michigan Dark Red Kidney beans. It makes a high-quality canned product.

The Charlevoix variety is a sixth generation selection from the cross Michigan Dark Red Kidney × Brazilian Red Kidney.

California White Kidney.—California White Kidney is a selection made from the old White Kidney variety. It was released by the California Agricultural Experiment Station in 1943.

Yellow Eye

New York or Michigan Yellow Eye.—New York or Michigan Yellow Eye is a large, white, round to oblong bean. It is an old variety with a large, yellow, oval spot on the hilum ("eye" of bean).

Steuben.—Steuben is a selection made from the old New York or Michigan Yellow Eye by the New York Agricultural Experiment Station. It was released in 1960. The variety has a slightly larger and more uniform seed and is a better yielder than is the parent variety.

New England Yellow Eye.—New England Yellow Eye or Old-Fashioned Yellow Eye has an irregular yellow pattern around the hilum. The pattern consists of a narrow strip of pigment from the front of the micropyle to the apex of the bean and extends around the micropyle. It forms a horseshoe around the anterior end of the hilum. Furthermore, broad wings extend forward along the sides of hilum from behind the caruncle.

Miscellaneous

Black Turtle Soup.—Black Turtle Soup (or *Venezuelan*) is a black bean grown in limited quantities in New York.

Perry Marrow.—Perry Marrow is a large, white bean developed by the Agricultural Experiment Station of Cornell University and released to seed companies in 1921 for propagation. It was derived from a cross between Wells Red Kidney and White Marrow. In 1942 the seed on the market was found to be a mixture of Perry Marrow, Pea, and other white beans. Reselections were made by the Cornell

station and planted in the field in rows. The strain of Perry Marrow grown for certification resulted from an increase of these selections.

Michigan Cranberry.—Michigan Cranberry is an old variety of the Horticultural type. It is grown largely in Michigan.

Jacobs Cattle.—Jacobs Cattle is a large, red and white mottled bean produced in Maine.

Soldier.—Soldier is a large, white bean with a small brownish red "soldier" pattern around the hilum. It is somewhat more kidney shaped and longer than is New England Yellow Eye. Soldier is grown in Maine.

SOIL TYPES

Dry beans are suited to many soil types. They grow best in well drained, sandy loam, silt loam, or clay loam soils high in organic content. They are very sensitive to excessive soil moisture; under this condition they are susceptible to diseases. Standing water will injure the plants in a few hours. Where drainage is poor, tile drains are essential to the production of good yields. Sandy soils are not well suited for bean production; but by building up the organic content, soils of this class produce good yields.

CROP ROTATION

Some system of crop rotation or crop diversification is usually necessary to maintain high yields and quality of beans. A rotation with at least 3- or 4-year intervals between bean plantings on any one field is a good practice. Successive cropping of beans is hazardous, because of the danger of losses from diseases whose organisms are able to survive in the soil or on plant refuse in the soil. For the same reason, it is risky to spread bean straw or manure from bean straw onto land immediately before beans are planted.

Although the bean is a legume, other legumes, such as alfalfa, sweetclover, red clover, and alsike clover, are grown in the bean rotation to supply nitrogen and to replenish the organic matter in the soil. Dry beans normally deplete the soil nitrogen, even though nitrogen-producing bacteria develop in nodules on the root system. However, they take less nitrogen out of the soil than do many other row crops. A standard recommendation for rotations in the Lake and Northeastern States is one or two row crops followed by small grains seeded to a hay, pasture, or green-manure crop.

Crop sequence within a rotation is important in bean production. Planting beans after certain crops may reduce the severity of bean root rot and may increase yields. Investigations in Michigan suggest that beans should follow corn, wheat, or a green-manure crop. A much higher incidence of root rot occurred when beans followed barley and when beans followed beans.

Crop sequence can also affect the expression of certain nutrient deficiencies. For example, zinc deficiency is much more noticeable in some varieties of beans planted after sugarbeets (fig. 8). The yields of beans that show zinc-deficiency symptoms are also lower. Nutrient deficiencies can be corrected by incorporating minor elements with the fertilizers and applying them at planting time (fig. 9).

BN 23784

FIGURE 8.—Sanilac beans in Saginaw County, Mich., in 1960. *A*, Normal plants following wheat; *B*, zinc-deficient plants following sugarbeets in the rotation. (Plants in *A* were in the row next to *B*.)

BN 23785

FIGURE 9.—Field of Sanilac beans growing in alkaline soils in Bay County, Mich., to which zinc sulfate was applied at planting time. Two center rows did not receive zinc.

When dry beans follow a leguminous green-manure crop in a rotation, the green-manure crop should be turned nnder before May 15. Sweetclover should be plowed under when it is 8 to 14 inches high. During seasons of subnormal spring rainfall, delaying the plowing under of the green-manure crop may damage the bean crop, because the green-manure crop may use most of the available soil moisture.

SOIL PREPARATION

The same farm machinery is used to prepare the soil for planting beans as is used for other row crops. Although the steps involved in preparing the land for seeding may vary according to the previous crop and the soil type, establishment of a friable seedbed is the best means for conserving soil moisture.

If a green-manure crop is not to be turned under, the type of soil and the terrain determine to a great extent the time to plow. Fall plowing usually provides a more friable seedbed in heavy soil. If there is danger of wind erosion and water runoff during the winter months, it is better to wait until spring to plow. A field cultivator or a chisel-type cultivator plow may be substituted for the conventional plow.

After the field is plowed, the disk and harrow are used to level the seedbed and control weeds. If the field was plowed early, secondary tillage to control weeds is usually necessary. Avoid packing the soil by excessive preparation with heavy farm equipment.

FERTILIZATION

Maximum bean yields cannot be obtained unless an adequate and balanced quantity of plant food minerals are present. Where the soil cannot supply the elements necessary for high yields, commercial fertilizer should be used.

To determine the amount and kind of fertilizer needed, the soil should be tested for available soil nutrients. Fertilizer recommendations are based on the results of soil tests, soil classification, previous cropping history, crop to be grown, and expected yield per acre. New York bean growers should follow the fertilizing recommendations presented in the publication entitled "Vegetable Production Recommendations," which is published annually and cooperatively by the New York State College of Agriculture, Cornell University, Ithaca, N.Y., and the New York State Agricultural Experiment Station, Geneva, N.Y. Michigan bean growers should follow the directions given in Michigan State University Extension Folder F–278, "How To Take Accurate Soil Samples," and Extension Bulletin E–159, "Fertilizer Recommendations for Michigan Crops." Information on soil classification can be obtained from published county soil survey maps and reports that are available at the county offices of the Extension Service and the Soil Conservation Service.

The need for fertilizers depends not only on the natural fertility of the soil, but on the other crops grown in the cropping system and the fertilizers applied to these crops. Liquid fertilizers, which are gaining in popularity in many areas, are just as effective as solid fertilizers, provided they are used correctly. The recommended placement of fertilizers for beans is 1 or 2 inches to the side and 2 inches below the seed. The seed should not be in contact with the fertilizers, because bean seed is very easily injured when it comes in direct contact with fertilizer.

BN 23786

FIGURE 10.—Zinc deficiency in beans over tile lines where calcareous subsoils have been brought to surface during tiling operations.

Zinc deficiency (figs. 8, 9, and 10) is becoming increasingly noticeable in beans grown on the alkaline soils of the lake bed areas in Michigan. Zinc deficient plants are stunted; have shortened internodes; show excessive branching; and have small, somewhat pointed leaves that are often distorted and necrotic along the edges. The deficiency is especially noticeable in beans grown over tile lines, on spoil banks where calcareous subsoil is mixed in with the surface soil, and in beans that follow sugarbeets. Zinc-deficient soils should be supplied with 3 to 4 pounds of zinc per acre, applied in the band fertilizer. As a preventive, 1 pound of zinc per acre is suggested. Michigan bean growers should be on the alert for new recommendations on the use of zinc in their fertilizer program—optimum rates, methods of formulation, and methods of application.

Manganese deficiency (fig. 11) frequently occurs in Michigan soils with a pH of 6.5 or higher. It may be corrected by including manganese in the fertilizer. Commercial fertilizer containing 1, 2, or 5 percent of manganese may be bought. The fertilizer should contain enough manganese to supply 5 to 10 pounds per acre.

When plant leaves show manganese or zinc deficiency, foliar sprays may be tried. Water-soluble manganese sulfate should be applied at a rate of 3 to 6 pounds per acre, and zinc sulfate at a rate of 1 to 2 pounds per acre. The nutrients may be mixed and applied in as little as 30 gallons of water per acre. Zinc foliar sprays are often ineffective.

Nitrogen deficiency may occur in some rotations. It may be prevented by applying 30 to 40 pounds of nitrogen per acre when the plants have two or three true leaves.

Detailed information on the use of fertilizers in your locality may be obtained from your county agent, from Extension Service specialists at the land-grant college or university in your State, or from your State agricultural experiment station.

BN 23787

FIGURE 11.—Normal Sanilac bean leaves (left) compared with manganese-deficient Sanilac bean leaves (right).

INOCULATION

Artificial inoculation of bean seed with nitrogen-fixing bacteria is considered of no advantage. Tests in Michigan, New York, and elsewhere on both old and new bean soil have shown no benefits from seed inoculation.

PLANTING

A corn, bean, or beet drill with removable plates is generally used to plant beans (fig. 12). Beans should be planted only deep enough to obtain good coverage and sufficient moisture to promote fast germination and growth. If the beans are planted too deep, they may be damaged by seed decay and damping-off organisms and may be injured by the seed-corn maggot as a result of delayed emergence.

Weather reports giving weekly forecasts should be helpful to the bean grower in determining how and when to plant. The temperature for the period after planting should be warm (above 65° F.), so the beans can germinate quickly. If the season is dry and there is little moisture in the surface soils and no immediate prospect of rain, the seeding rate should be increased and the beans should be planted in contact with moisture even if this is 3 to 4 inches deep. Contact with moisture will assure quick germination. On the other hand, if there is a forecast of heavy rains and the soil is fine in texture, the beans should be planted shallow (1 to 1½ inches). If the forecast is for cold and wet weather they should not be planted until the weather is favorable.

Planting dates vary in different localities. However, beans should not be planted until the soil temperature is above 65° F., a temperature that will assure immediate germination and emergence. All conditions

BN 23788

FIGURE 12.—Planting beans with a four-row drill. With a planting drill of this type, fertilizer can be banded 1 or 2 inches to the side and 2 inches below the seed. Attachments for banding systemic insecticides are easily mounted on this equipment.

that favor rapid germination and emergence will minimize the damages from fungus and insect injury. Generally, field beans are planted from May 25 to June 15 in the Lake and Northeastern States. If root rot is a problem, planting should be delayed until the soil is warm (June 5 or later). Short-season beans are available in the Pea bean types; they can be planted the latter part of June and still mature in those areas where the average frost date is September 20 to 30.

Row widths of 28, 30, and 32 inches are ordinarily recommended. The width most common in the Lake and Northeastern States is 28 inches. In experiments conducted in Michigan over a 6-year period, it was found that beans grown in 28-inch rows yielded only slightly less than those grown in 21- and 24-inch rows; the difference was not appreciable. Even increasing row width to 32 and 36 inches did not lower yield appreciably for Seaway, Sanilac, and Michelite varieties. By using wider row spacings, beans, corn, and sugarbeets can all be planted in rows of the same width and the same tractor may be used in planting and cultivating the three crops with a minimum of adjustment between crops. The time and labor saved may offset any lower yields which may occur. Figure 7 shows Seaway beans planted in 38-inch rows. The grower has been planting beans and corn in 38-inch rows.

Planting rates depend on variety, seed size, and width of row. Following are the rates recommended by New York and Michigan for rows 28 to 32 inches wide:

State and variety	*Pounds of seed per acre*
New York:	
Red Kidney, Marrow, Yellow Eye	75 to 100
Pea, Black Turtle Soup	30 to 40
Michigan:	
Red Kidney	80
Yellow Eye, Cranberry	60
Pea	30 to 40

Although these rates are considered too heavy by many growers, they increase the chances of a good stand if there is much danger from damping-off or the seed-corn maggot, or if the ground becomes crusted.

CULTIVATION

The main purpose of cultivation is weed control. Weeds are readily destroyed shortly after their emergence. At this stage, little root development has taken place. Weed control should begin during the preparation of the seedbed and should continue after the beans are planted. Special weeders or a spike-tooth harrow may be used from the second or third day after planting until the plants are 4 to 5 inches tall. These implements should not be used at the time the plants are emerging from the ground and while the stems still have the crook

in them. At this stage the plants are brittle and easily injured. Furthermore, the weeders should be used in the afternoons or when the plants are less turgid and brittle, and therefore are less easily broken.

If heavy rains pack the soil so the beans cannot emerge, the soil surface should be loosened with a spike-tooth harrow, a rotary hoe, or weeder to prevent complete loss of the beans.

Do not cultivate more frequently or deeply than is necessary to control the weeds (fig. 13). Cultivate with care late in the season, so as to avoid injuring the roots extending out between the rows just beneath the soil surface. Injury to the feeding roots at blossoming and pod-setting time may cause wilting of the plant, blossom and pod drop, and an eventual reduction in yield.

Thorough cultivation does not always remove all the weeds in a field. Weeds not removed by cultivating equipment should be removed with a sharp hoe or cut with a corn knife. Weeds not only interfere with crop growth but also hinder harvesting and curing of the beans.

Never cultivate beans while they are wet from either dew or rain, because disease organisms are more easily carried from plant to plant by farm implements when the plants are wet.

CHEMICAL WEED CONTROL

Chemical weed control is recommended where weeds are difficult to control by other methods.

BN 23789

FIGURE 13.—Cultivating Pea beans planted in 28-inch rows, using a four-row cultivator.

EPTC [5] has been used successfully by several growers in Michigan to control annual weeds on Red Kidney and Pea beans. It should be applied before planting at a rate of 3 pounds per acre. Since the material is extremely volatile, it should be worked into the soil immediately after application. The most successful users applied the material as a spray immediately ahead of the harrow or disk. New York recommends EPTC for Red Kidney beans only and in the granular form at a rate of 3 pounds of active ingredients per acre. This is equivalent to 60 pounds of 5-percent granular material per acre. They suggest using it on a trial basis on other bean varieties.

DNBP [6] amine salt can be used as a preemergence spray to control annual weeds. If applied immediately after planting, it should be used at a rate of 4½ pounds per acre (1½ gallons of liquid concentrate). But if applied just before emergence, it should be used at a rate of only 3 pounds per acre (1 gallon of liquid concentrate). To reduce costs, the material can be applied in a band spray. DNBP is not effective when the soil is dry. Before applying granular material, growers should determine how much *active chemical* they wish to apply per acre; then they should apply it at a uniform rate—the same amount of active chemical on each acre.

Sow thistle and Canada thistle have always been a menace to bean growers. Many growers have successfully controlled these perennial weeds by applying ¼ to ½ pound of actual 2,4-D [7] per acre, 6 to 10 days before planting. This practice is not recommended, however, because, under certain conditions, the compound may injure the plants and delay maturity. Furthermore, if EPTC is applied to the same field, interactions between the two chemicals may injure the plants.

The effects of chemicals on both beans and weeds depend on soil type, moisture, temperature, and type and variety of beans. For this reason, it is advisable to consult your county agricultural agent, Extension Service specialist, or State agricultural experiment station before attempting to use herbicides on beans.

HARVESTING

Harvesting is a crucial stage in bean production. To keep the period between pulling and threshing (or combining) as short as possible, harvesting should be delayed until most of the pods are dry and the beans have hardened. Although high temperature and humidity sometimes damage mature beans while they are standing in the field, these conditions generally cause greater and more frequent losses while the crop is curing in windrows or bunches. The more immature the crop is at the time of pulling, the longer the plants have to remain

[5] Chemical name: *Ethyl N,N-di-n-propylthiocarbamate.*

[6] Chemical name: *4,6-dinitro-o-sec-butylphenol.*

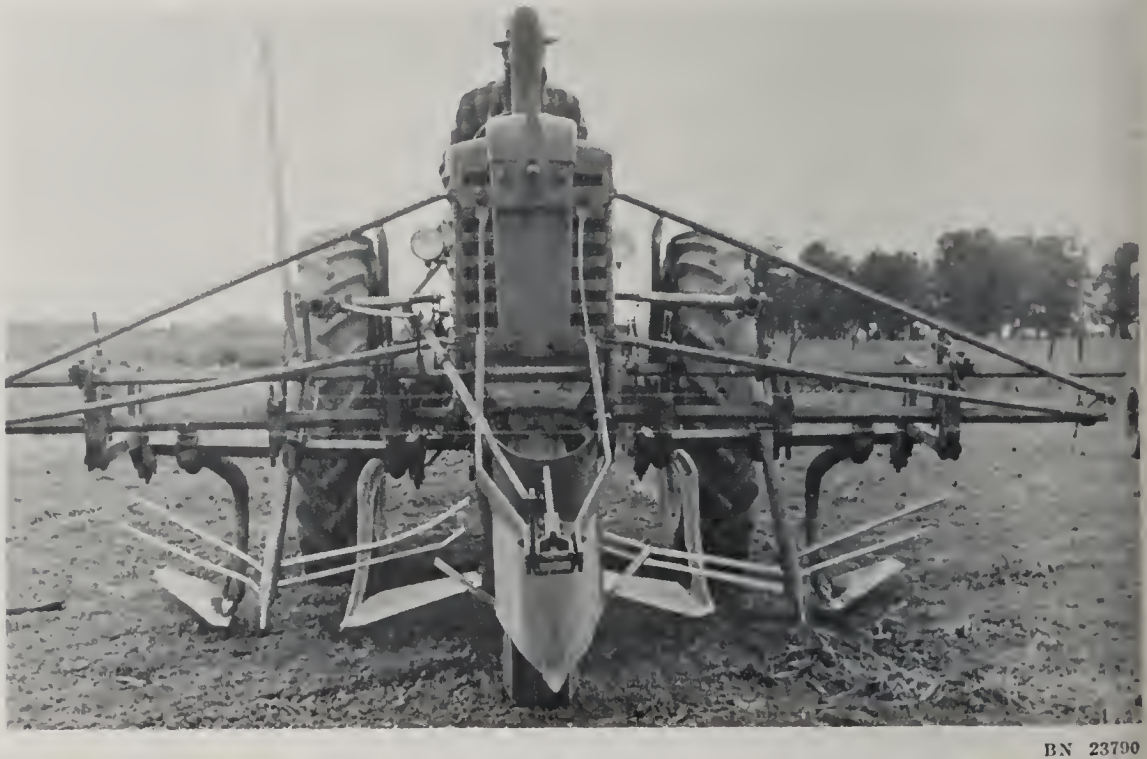
[7] Chemical name: *2,4-dichlorophenoxyacetic acid.*

on the ground to mature, and the greater are the chances that the beans may become moldy and discolored.

With modern equipment, two men can harvest 20 or 30 acres of dry beans in 1 day. The beans are cut below the surface of the ground with large steel blades mounted on a tractor (fig. 14), a process referred to as pulling beans. Pulling is followed by windrowing. Many growers use a one-man tractor-drawn puller-windrower that pulls the beans, elevates them and shakes off the stones and soil, and windrows them all in one operation (fig. 15.) After the beans have cured, a one-man self-propelled combine threshes them directly from the windrow and discharges them into a truck driven alongside (fig. 16).

The bush-type Pea bean varieties (Sanilac, Seaway, and Gratiot) were developed to shorten the time necessary to leave the beans in the windrow, or possibly to eliminate this need. If beans are left standing until all the plants are mature and the beans have dried down in the pods, then the beans can be pulled and windrowed during the morning hours while the plants are damp and the pods are tough. This will reduce shattering of the beans. Pulling is immediately followed by windrowing before the plants have a chance to dry out. Later in the morning or early afternoon the beans should be ready for threshing. Care should be taken not to pull more beans in the morning than can be readily threshed in the afternoon and evening.

The vine-type Pea beans and colored bean varieties ordinarily cannot be pulled and threshed the same day. Curing can be speeded up by turning the beans in the windrow daily, either by hand or with the windrower. In fair weather most bean varieties are cured in a day or two and are then ready for threshing.



BN 23790

FIGURE 14.—Four-row tractor-mounted cutting blades for harvesting beans. Beans are cut about 1 inch below ground.

BN 23791

FIGURE 15.—Pulling and windrowing Sanilac beans in Michigan with a harvester and an attached windrower.

BN 23792

FIGURE 16.—Threshing beans from the windrow with a self-propelled combine. Trucks can be loaded without stopping the combine, and the beans can be hauled to farm storage bins or local elevators.

The windrow method of curing works well if the weather is favorable. Occasionally wet, humid weather sets in during harvesting, and additional curing is needed. Well-made stacks built around posts in the field allow the beans to complete their curing from newly windrowed plants.

The stacking procedure is as follows: Drive a 7-foot steel fencepost or heavy stake firmly into the ground. Place a 1-foot layer of clean straw around the post, making a circle about 3 feet in diameter. Build the bean stack around the post with straight sides to a height of at least 2 feet above the top of the post. The sides may be 6 inches wider at the top than at the bottom.

A maximum of high-quality beans can be obtained by stacking, even though the beans are harvested before they are uniformly ripe.

The grower should take the utmost precautions to prevent injury to the beans during harvest. Beans with cracked seedcoats are desirable neither for canning nor for seed. In fact, commercial canning companies refuse to accept beans with a large number of cracked seedcoats. Constant vigilance is required on the part of the combine operator, who must adjust the speed of the cylinder so that all the beans are threshed but not injured. The drier the beans, the more easily they are threshed and the more easily they are injured. Since the amount of moisture in the beans can change considerably during the day, frequent adjustments may be necessary. Investigations at Michigan State University showed that spraying the beans in the windrow delays drying out during the day and reduces the damage that occurs to beans in the combine. Placing a damp, absorbent material, such as damp sawdust or damp corncobs, to dry beans in the combine hopper, truck, or bin adds sufficient moisture and weight to the beans in 2 hours to prevent further damage in handling.

DEFOLIATION

Normally, it is not necessary to use chemical defoliants in field bean production. However, natural defoliation is sometimes delayed or does not occur uniformly on plants in the field. Where this is true, chemical defoliants are desirable. They speed up ripening and assist in uniform maturing of the crop.

Commercial formulations containing magnesium chlorate or sodium chlorate and small quantities of boron or magnesium chloride should be applied at a time when the leaves are coloring and the beans in the pod are well developed. The defoliant should be applied when temperatures are above 60° F. and no rain is expected for at least 6 hours. Chemical defoliants will probably be used to a much larger extent should direct combining from the standing row become feasible.

PRODUCTION COSTS

What does it cost to produce an acre of dry beans? Researchers in Maine and New York determined the costs in 1958 and researchers in Michigan in 1962. The Maine values are for Yellow Eye production. New York for Light Red Kidney production, and Michigan for Pea bean production. The growing and harvesting costs, which include all fixed and variable costs, for Maine were $111.74 per acre. This included a cleaning (picking) cost of $14.52. Michigan's $67.90 cost per acre for dry bean production is based on estimated costs and returns from Sanilac County. New York sampled the Cayuga-Seneca Counties area, where the costs were $77.65 per acre, and the Livingston-Wyoming Counties area, where the costs were $92.77 per acre.

MARKETING, CLEANING, AND GRADING

The quality of the crop and the price at harvesttime determine for most farmers whether they market the beans promptly after threshing or store them on the farm. Many farmers, however, consistently follow one practice year after year regardless of price at harvesttime.

Limited space is available in most areas for commercial storage of beans for farmers. Most commercial space is used by elevator interests to store the beans they buy at harvesttime for processing and sale throughout the rest of the year.

Since the combine has come into general use for harvesting beans, most beans are delivered to country elevators in bulk by truck. The beans are then weighed, sampled to determined quality and price, and dumped into a pit for elevation into the elevator.

Pea beans are purchased from farmers on the basis of the price for Choice Handpicked grade. The sample from a farmer's load is "picked" to sort the good beans from the splits, discolored beans, stones, straw, and other foreign material. The amount paid to the farmer for the load is determined by multiplying the original net weight of his delivery in pounds minus the weight of the "pick" by the price per pound for Choice Handpicked grade. From this price is subtracted a picking charge per pound, which varies from year to year, and depends on relative costs of operation.

Most country elevators process the beans by putting them over a cleaner, stoner, and jigger or gravity mill, the extent of their processing depending upon their facilities and the quality of the crop.

The condition of beans on hand largely determines the degree of processing and the method of disposal of the beans by the country elevator man. Following crops of good quality, he is often able to process the beans sufficiently to meet the standard for No. 1 grade for screened beans (see below) and ship direct to merchants and large users in 100-pound bags. But when beans are of low quality and a high proportion must be picked out because of discoloration, the country elevator man may not be able economically to process his beans sufficiently to meet the higher grades. In this case he ships them in bulk carloads to major processing terminals at which electric-eye sorting machines pick the beans to a Choice Handpicked grade.

Beans are graded according to their quality by private, State, and Federal inspectors. The State bean shippers associations maintain their own inspection services for their members, but these are not official so far as the State and Federal departments are concerned. The State of New York adopted the United States Standards for inspection, whereas the State of Michigan uses two standards, one based on State regulations and the other on Federal regulations. The percentage of total defects permitted under United States Standards for beans are given below.

U.S. Grade	*Percentage of defects (splits, damaged beans, contrasting classes, and foreign material) permitted* [1]
Handpicked or specially processed beans: [2]	
U.S. Choice Handpicked	1.5
U.S. No. 1 Handpicked	2.0
U.S. No. 2 Handpicked	4.0
U.S. No. 3 Handpicked	6.0
Screened beans: [3]	
U.S. No. 1	2.0
U.S. No. 2	4.0
U.S. No. 3	6.0

[1] Data obtained from Consumer and Marketing Service, U.S. Department of Agriculture, Revised United States Standards for Beans (effective Sept. 1, 1959).

[2] Except Blackeye, Cranberry, and the various classes of lima beans.

[3] Cranberry bean standards are 4.0, 6.0, and 8.0 percent, and Pinto bean standards are 3.5, 5.0, and 8.0 percent, for U.S. Nos. 1, 2, and 3, respectively.

Two additional U.S. Standard grades of screened beans are U.S. Substandard and U.S. Sample. The U.S. Substandard grade includes those beans that do not meet the requirements of the U.S. Nos. 1, 2, and 3 or the U.S. Sample. The U.S. Sample grade includes beans of any of the classes that are musty, sour, heating, materially weathered, weevily, or are otherwise of low quality.

Michigan State standards are used in the sale of all Michigan beans except those that are sold to State agencies outside Michigan, to Federal agencies, and for export (unless inspection under Michigan standards of beans for export is requested). The percentage of total defects permitted under Michigan Standards for dry edible beans is given below.

Michigan Grade	*Percentage of defects (splits, damaged beans, contrasting classes, and foreign material) permitted* [1]
Handpicked beans: [2]	
Michigan Choice Handpicked	1.5
Michigan Prime Handpicked	3.0
Screened beans: [2]	
Michigan No. 1	2.0
Michigan No. 2	3.0

[1] Data obtained from Michigan Department of Agriculture Regulation No. 523, May 15, 1959.

[2] Cranberry and Yellow Eye beans may contain an additional 2 percent split, but otherwise sound beans of the same class in any of the established grades. Total maximum tolerance for defects in Kidney beans shall be 2 percent in the Choice Handpicked and No. 1 grades and 4 percent in Prime Handpicked and No. 2 grades.

An additional Michigan screened beans grade is Michigan Picking Stock. It includes beans that do not meet the specifications for any of the established grades.

All beans, except those shipped as "picking stock" from one bean plant to another for further processing, must be inspected before shipment by a licensed bean inspector supervised by the State department of agriculture and must carry an inspection certificate citing the grade.

In Michigan the Department of Agriculture supervises the inspection service on the basis of an agreement or contract with the Michigan Bean Shippers Association. These two agencies jointly (and solely) conduct the inspection service on the basis of official Michigan grades and standards. The same bean inspectors that are licensed by the Michigan Department of Agriculture also do the inspection work that is based on U.S. standards. This is made possible by means of a three-way agreement between the U.S. Department of Agriculture, the Michigan Department of Agriculture, and the Michigan Bean Shippers Association. The latter organization is located in Saginaw, Mich.

Three colored types—Red Kidney, Cranberry, and Yellow Eye—are handled in most respects like Pea beans, except they are bought on the basis of No. 1 grade and for the most part are processed to No. 1 grade.

Cull beans usually find a market among livestock feeders or feed manufacturers. Split beans become a sales problem, especially in dry years, when the handling and processing cause a high percentage of splits.

DISEASES

In some years, losses to bean growers from disease infestations amount to several million dollars. Some bean growers have sustained complete loss from disease.

In general, losses caused by bean diseases can be held to a minimum by following these cultural practices: (1) Plant disease-resistant varieties when available; (2) use disease-free seed (certified seed is recommended); (3) practice at least a 3- or 4-year crop rotation; (4) keep fields clean by plowing under bean refuse; (5) avoid working in beanfields while they are wet; (6) treat the seed with recommended chemicals to prevent damping-off, seed decay, and seed-corn maggot injury. Airborne diseases can be controlled by spraying the field with chemical fungicides.

Because seed infection is not easily detected in colored beans, scrutinize colored beans before planting. Obtain certified seed if it is available.

The economically important diseases of beans are described fully in Agriculture Handbook 225, "Bean Diseases—How To Control Them." A copy of this handbook can be obtained by writing to the Office of Information, U.S. Department of Agriculture, Washington, D.C., 20250.

INSECTS

For information on insects affecting the dry bean crop in the Lake and Northeastern States, and on current recommendations for insect control, call or write your county agricultural agent, your State agricultural extension service or agricultural experiment station, or the U.S. Department of Agriculture, Washington, D.C., 20250.

PRECAUTIONS

Herbicides are poisonous to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Keep herbicides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and pets cannot reach them.

Avoid repeated or prolonged contact of herbicides with the skin. Avoid inhalation of herbicide dusts or mists.

Avoid spilling herbicides on your skin, and keep them out of the eyes, nose, and mouth. If any is spilled on skin or clothing, wash it off the skin and change clothing immediately.

When handling herbicides, wear clean, dry clothing.

Wash your hands and face before eating or smoking and immediately after completing herbicide application.

To protect fish and wildlife, do not contaminate lakes, streams, or ponds with herbicide. Do not clean spraying equipment or dump excess spray material near such water.

To minimize losses of honeybees and other pollinating insects, make herbicide applications, when possible, during hours when the insects are not visiting the plants. Avoid drift of herbicides sprays to nearby crops or livestock. Avoid drift of herbicides into bee yards.

Empty containers are particularly hazardous. Burn empty bags and cardboard containers in the open or bury them. Crush and bury bottles or cans.

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CHEMICAL CONTROL OF PLANT-PARASITIC NEMATODES

Agricultural Research Service
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CONTENTS

	Page
How nematocides work in soil	3
When to apply nematocides	5
Land preparation	6
Calibrating the equipment	6
Overall treatment	8
Row treatment	14
Strip treatment	17
Postplanting sidedressing treatment	18
Spot treatment	18
Drench and irrigation water application	18
Fumigating plant beds	20
Treatment of potting and rooting soil	22
Controlling nematodes in home gardens	23
Treating lawns, shrubs, and trees in home yards	26
Supplementary management practices	26
Chemical residues and plant tolerances	27

PRECAUTIONS

If pesticides are handled or applied improperly, or if unused parts are disposed of improperly, they may be injurious to humans, domestic animals, desirable plants, and pollinating insects, fish, or other wildlife, and may contaminate water supplies. Use pesticides only when needed and handle them with care.

When using nematocides, follow the manufacturer's directions exactly. Ask your county agricultural agent or your State agricultural experiment station for advice as to the best method of application and possible harmful effects. Variations in soils and climate may affect the action of the nematocides.

Handle nematocides with extreme care. Avoid prolonged breathing of the fumes. Do not allow the liquid to come into contact with the skin. If the liquid is accidentally splashed on clothing, including gloves or shoes, remove the garments without delay; do not wear them again until they are washed, cleaned, or at least thoroughly aired for a day or two. Never risk getting the material in your mouth. If it is splashed in your eyes, wash it out with large quantities of water and consult a physician.

Keep children and pets away from fumigated soil. Potting and rooting soil that has been treated with nematocides should not be used until all traces of fumigant odor have disappeared.

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CHEMICAL CONTROL OF PLANT-PARASITIC NEMATODES

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Plant-parasitic nematodes occur in all soils. When land is brought under intensive cultivation, nematodes often become a serious problem. Chemical deterrents (nematocides) have come into wide use as an effective means of controlling nematodes.

Nematode control is a matter of economics. Only crops producing high returns per acre, such as tobacco, truck crops, and orchard crops, lend themselves to use of nematocides. Many field crops, such as soybeans, small grains, and corn, do not have sufficient value per acre to make chemical control profitable. However, lawns, home gardens, and other small plots can usually be treated for a relatively small investment in chemicals and equipment.

Complete eradication of nematodes is seldom practical. Complete eradication is attempted only when land is under quarantine for dangerous nematode species. In such cases application rates may be four to eight times those normally used. For normal use, recommendations are usually aimed at killing the largest possible number of nematodes with the smallest possible amount of nematocide. In most cases the recommended dosage kills about 85 to 90 percent of the nematode population.

Approximately 20 chemicals and chemical mixtures are manufactured for control of nematodes (see table). This handbook does not include information on dosage. Correct dosage varies with the type of chemical, the crop, the soil type, and the method of application. County agents, extension specialists, and State experiment station specialists can supply specific recommendations. Manufacturers' directions should be read carefully.

HOW NEMATOCIDES WORK IN SOIL

Most proprietary nematocides, such as D-D (dichloropropene), EDB (ethylene dibromide), DBCP (dibromochloropropane), and MBR (methyl bromide), are soil fumigants with relatively high volatility. In the soil, they form vapors that move several inches from the point of application; the distance of movement is influenced by soil porosity, particle size, soil temperature, soil moisture, and percent of colloidal and organic matter.

The degree of kill is determined by the concentration of the nematocide in the soil and the length of time the nematodes are exposed to the killing fumes. These factors are seldom under precise control of the user. In practice, kill can best be increased by increasing the application rate. However, increasing the application rate beyond a certain point does not increase the crop yield. Recommended nematocide dosages are those which have been found by experiment to produce the best crop yield increases with the least amount of nematocide. In most cases the recommended dosage kills about 85 to 90 percent of the nematodes.

Chemicals available for control of nematodes

Chemical	Trade name [1]	When to apply	Volatility	Form
Methyl bromide+chloropicrin (MBR-CP) [2]	Dowfume MC–2, Bromo-O-Gas, Bed Fume.	Before planting	Very high	Liquid, gas.
Methyl bromide+chloropicrin in petroleum solvent.[2]	Brozone	do	do	Liquid.
Methyl bromide+chloropicrin+propargyl bromide (MBR-CP-PBR).[2]	Trizone	do	do	Liquid, gas.
D-D+methyl isothiocyanate (MITC) [2]	Vorlex	do	High	Liquid.
D-D+chloropicrin [2]	Nemex	do	do	Do.
Sodium methyldithiocarbamate (SMDC) [2]	Vapam, VPM	do	do	Do.
3,5-dimethyltetrahydro-1, 3–5, 2H-thiadiazinethione (DMTT).[2]	Mylone	do	do	Wettable powder or granules.
Ethylene dibromide (EDB)	Dowfume W–85 Garden Fume, Soil Fume Caps.	do	Moderate	Liquid.
1,3-dichloropropene and 1,2-dichloropropane (D-D).	D-D Mixture Vidden-D.	do	do	Do.
1,3-dichloropropene (DCP)	Telone	do	do	Do.
Ethylene dibromide+1,3-dichloropropene (EDB-DCP).	Dorlone	do	do	Do.
1,2-dibromo-3-chloropropane (DBCP)	Nemagon, Fumazone.	Before and after planting.	Low to moderate	Emulsifiable concentrate (liquid or granules).
Tetrachlorothiophene (TCTP)	Penphene	do	do	Do.
0,0-diethyl 0-2-pyrazinyl phosphorothioate [3]	Zinophos, Nemaphos, Cynem.	do	Low	Do.
0,-2,4-dichlorophenyl 0,0-diethyl phosphorothioate.[3]	V–C 13 Nemacide	do	do	Emulsifiable concentrate (liquid).

[1] Although a search for all trade names was made, some may have been omitted unintentionally.
[2] Also controls soil insects, weeds, and fungi.
[3] Also controls soil insects. Used as a drench or soak on turf and ornamentals.

Because nematocide vapors move through the soil, anything that restricts the size of soil pore spaces or creates a discontinuous system will limit diffusion and reduce the effectiveness of nematocide treatment. Poorly prepared land has limited pore space; well-prepared land has a friable tilth that permits diffusion of nematocide vapors into all parts of the soil.

If soil moisture content is extremely high, pore spaces will be filled with water, which also restricts diffusion of nematocides. Best nematode control is obtained when the soil moisture is about 80 percent of field capacity. According to rule of thumb, the soil moisture should be suitable for good seed germination when soil fumigants are applied. Under these conditions nematocide vapor moves readily in soil. On the other hand, if the soil is too dry when soil fumigants are applied, results will be poor because the vapors will escape from the soil before appreciable kill can take place.

A number of nematocides have low volatility and cannot be considered true soil fumigants because the active ingredients do not diffuse through the soil to any great extent. Dispersion of these chemicals depends on mechanical mixing, or movement by irrigation water and natural rainfall.

Clay soils and soils high in organic matter require from 20 to 40 percent more nematocide for effective control than sandy soils. This is because clay soils have more total pore space to be filled with fumigant vapor than sandy soils and because colloidal and organic matter often adsorb some of the fumigant vapors.

Most soil nematocides have some effect on plant growth if improperly applied—that is, they are poisonous or phytotoxic. They may prevent or delay germination or emergence of seedlings, kill or damage the roots of transplants, or have other undesirable effects. Because of this, time must usually be allowed between application of the nematocide to the soil and planting. During this time, the chemical decomposes, dissipates into the air, or is leached out.

There are important exceptions to this rule; some nematocides can be applied at planting time or around the roots of growing crops that are tolerant to the nematocide. But these same nematocides may be highly toxic to other kinds of seeds, transplants, or growing plants.

When properly used, nematocides eliminate nematodes as a limiting factor in plant growth and permit normal, healthy plant growth.

WHEN TO APPLY NEMATOCIDES

Local soil and weather conditions determine the time for application of nematocides.

Preplanting applications of nematocides are often made in the early spring, 2 to 3 weeks before the customary planting date. If cold, wet weather persists, the interval between treatment and planting must be increased to guard against seedling damage.

In northern parts of the country, fall treatment usually gives better nematode control than spring treatment. All traces of chemical residue will have disappeared by spring planting time, thus precluding any possibility of crop damage. Nematodes will not become reestablished during the winter if no susceptible crops are planted between treatment and spring planting time.

In the Gulf Coast States, where winters are generally mild, some nematocides can be applied between December and February with good results. This allows ample time for the chemicals to escape from the soil before spring planting; at the same time, the cool weather prevents

chemicals from evaporating too rapidly to achieve an effective kill.

When soil temperatures are 75° F. or higher at a 6-inch depth, soil fumigants usually volatilize quickly and escape from the soil before lethal concentrations can be accumulated in a sizable volume of soil. On the other hand, if the soil temperature is below 40° F. complete volatilization and diffusion will not occur. For best results, therefore, the soil temperature should be between 50° and 70° F. Chemicals containing ethylene dibromide are not effective if the soil temperature is much below 50° F., and therefore should not be applied during the winter.

In areas of heavy rainfall, nematocide application may have to be delayed because of excess soil moisture. If heavy rainfall follows application, planting may have to be delayed by as much as 4 weeks to prevent crop damage. If you can detect no fumigant odor at a soil depth of 6 to 12 inches, the soil is usually sufficiently free of fumigant to permit planting of seeds.

LAND PREPARATION

Soil that is to be fumigated should be prepared long enough in advance of chemical treatment to allow decomposition of all aboveground plant parts as well as all roots and tubers. The land should be mowed, harrowed, and plowed to insure quick rotting of plant refuse.

Undecomposed litter prevents even distribution of chemicals, interferes with fumigation equipment, and prevents proper sealing of the soil surface. Undecomposed plant parts also contain nematodes and nematode eggs; the plant fibers protect these nematodes and eggs from contact with nematocide fumes.

Undecomposed litter in the surface soil can be buried at the bottom of the plow furrow by mounting a disk hiller in front of the wing of a moldboard plow. The disk moves the top 2 or 3 inches of soil into the bottom of the furrow ahead of the main furrow slice (fig. 1). Similar attachments are available for the tillage disk. The method buries litter deep enough so that it will not clog fumigation chisels.

If weeds become reestablished following initial plowing, the land should be harrowed or replowed a few days before applying nematocides.

Roots of many woody plants, particularly cotton, vines, and many trees, will not decompose quickly. In such cases it may be necessary to grow nonwoody plants on the land for at least 1 and preferably 2 years before applying nematocides. This will allow sufficient time for the woody roots to decompose. In the case of tree crops, such as citrus and peaches, 2 years should always be allowed for the roots to decompose.

CALIBRATING THE EQUIPMENT

Application equipment must be calibrated, or adjusted, so that the correct amount of chemical will be applied evenly over the entire field. Inaccurate calibration is a common cause of dissatisfaction with nematocides. Overdosage results in delayed planting and, frequently, crop damage and yield losses. If too little nematocide is applied, control will not be effective.

Read the manufacturer's label carefully, noting the recommended dosage and method of application for a given crop. The label will show the percentage of active ingredient contained in the manufactured formulation. If the recom-

BN 24029

Figure 1.—**Surface litter can be buried in the bottom of the plow furrow where it will not interfere with fumigation chisels. The litter is scraped into the furrow by the concave disks, then covered with soil by the wings of the plows.**

mended dosage is given as active ingredient, the user will have to calculate the amount of manufactured formulation that will be needed.

Two principal methods of nematocide application are (1) row treatment and (2) overall treatment. Dosage recommendations for row treatment are based on the amount of nematocide needed per linear foot of row. Thus wide-row spacings require less chemical than close-row spacings. Recommendations for overall treatment are based on the amount of chemical needed to treat 1 square foot of soil; the spacing of the crop grown on the soil is irrelevant.

To calibrate tractor-mounted equipment, the speed of the tractor must first be determined. Meter devices on the applicator can then be adjusted to deliver the recommended amount of chemical in the time required for the tractor to travel 100 feet.

Tractor speed can be easily measured by noting the number of seconds required to drive the tractor 100 feet. The tractor should be timed on the plowed field to be treated, with the equipment at operating depth. If the tractor has a speedometer, its speed per second can be calculated by multiplying miles per hour by the factor 1.46. Ten miles per hour, for example, equals 14.6 feet per second.

Equipment manufacturers furnish charts and graphs that aid in calibrating, but these are of no value if a pressure gage becomes inaccurate, if substitute replacement parts are used, or if equipment becomes badly worn or damaged. The following formulas can be used to determine the amount of chemical needed for any method of application.

Formula for Liquids

In the formula below, B is the width of treated band in inches, C is the number of milliliters (cc) of chemical applied per foot, R is the distance between crop rows in inches, and D is the distance between applicator chisels in inches. The numbers are constant factors.

Band application:

$$\frac{11.5 \times B \times C}{R} = \text{gallons per acre}$$

Row or furrow application:

$$\frac{138 \times C}{R} = \text{gallons per acre}$$

Overall chisel application:

$$\frac{138 \times C}{D} = \text{gallons per acre}$$

Liquid sprayed on soil surface:

$11.5 \times C = \text{gallons per acre}$

Formula for Granules or Dusts

In the formula below, B is the width of treated band in inches, G is the number of grams applied per foot, R is the distance between rows in inches, and D is the distance between applicator disks or chisels in inches. The numbers are constant factors.

Band application:

$$\frac{96 \times B \times G}{R} = \text{pounds per acre}$$

Row and furrow application:

$$\frac{1152 \times G}{R} = \text{pounds per acre}$$

Overall chisel application:

$$\frac{1152 \times G}{D} = \text{pounds per acre}$$

Granules spread on soil surface:

$96 \times G = \text{pounds per acre}$

The following formula for overall chemical application as a drench or in irrigation water can be used to determine the amount of chemical applied per acre:

$0.027 \times P \times I = \text{gallons or pounds applied per acre}$

In this formula, 0.027 is a constant factor, P is parts per million (ppm) or pounds or gallons of chemical per 1 million gallons of water, and I is number of acre-inches of water applied, assuming 1 acre-inch is equal to 27,154 gallons of water.

Several precautions should be taken to insure accurate calibration and application of nematocides. The tractor should be moving forward and the nematocide flowing before the fumigation equipment is put into the ground; this will prevent clogging of chisels. The entire application system should be checked periodically during operation to guard against leaks and stoppages. Rusty containers should never be used for nematocides.

Chemical quantities are often expressed in terms of metric measurement. Users may find it convenient to know that the ordinary kitchen measuring cup holds one-half pint or 473 milliliters, that 1 pound is 454 grams, and that 1 ounce is 28.4 grams. (For more detailed conversion information, see p. 28.)

OVERALL TREATMENT

Overall treatment of soil consists of applying nematocides evenly over the entire field. Essential parts of an overall fumigating machine are the chemical storage tank, the metering device, delivery tubes, soil applicators and, usually, a smoothing and firming drag.

The most commonly used machine is the chisel applicator. It consists of shanks (or tines) spaced evenly across a tool bar, or cultivator frame, at intervals of 6 to 12 inches (fig. 2). The applicator foot, or chisel, can be of several designs; one of the best is the chisel designed for

BN 24031

Figure 2.—**Overall chisel applicator equipped with coil-regulated, gravity-flow application system. Nematocide flows from the storage tank, through the metering coils, down the tubes, and into the soil behind the chisels.**

application of anhydrous ammonia. The chisel will function best if the shanks are staggered, with every other shank several inches forward or backward on the tool bar. This helps keep the machine from choking with soil and trash.

Chisels may tend to clog in rocky, stiff, or trashy soil. This difficulty can be overcome by using rolling fins (colters) that cut through the soil ahead of the chisels (figs. 3 and 4). Backsweep chisels that will slip over obstructions have been designed, but they are sometimes difficult to keep in the soil at the necessary depth.

Subsurface application of nematocide can be made with a blade 4 to 6 feet wide that runs 6 to 8 inches beneath the soil with its flat surface

BN 24007

Figure 3.—Overall pressure-applicator equipped with colters that cut through the soil ahead of the chisels. The fumigant pump is driven by the groundwheel but provides accurate dosage independent of ground speed.

BN 24010

Figure 4.—Caterpillar tractor designed for large-scale application of nematocides in soil that is heavy or contains obstructions.

parallel to the soil surface (fig. 5). Nozzles mounted under the blade spray an overlapping pattern, making possible the most uniform application of soil fumigants that has thus far been devised (1965).

The simplest machine to build is the plow applicator. It consists of a chemical applicator attached either to a moldboard plow (fig. 6) or to a tillage disk. Two outlet tubes are usually required for each furrow if a gravity-flow system is used, but the entire bottom of the furrow can be sprayed from a single outlet if a pressure system is used. The delivery tubes discharge chemical into the bottom of the open furrow. The nematocide is covered instantly by the plow. Best results are usually obtained when the land is prepared as if for planting, then fumigated with the plow applicator.

Chemicals can be plowed under as the land is initially broken if the soil is a loose type and if surface litter has been previously destroyed. If large clumps and slices are formed during plowing, soil fumigants will escape prematurely through the openings in the soil. Soil such as this can be sealed by light harrowing or cultipacking.

Nematocides are sometimes applied in granular form rather than as liquids. Granular nematocides can be applied with grain drills or fertilizer spreaders. Granules should be placed 4 to 6 inches deep behind disks or fertilizer chisels mounted 6 to 12 inches apart (fig. 7).

A less efficient method of applying granules is to spread them on the soil surface and immediately invert the soil by plowing. The plow should have a disk that will scrape surface soil into the bottom of the furrow before the remainder of the furrow is inverted (see fig. 1). If this method of application is used, two tractors with gangplows will be needed to turn under the chemical spread by one fertilizer spreader. The spreading and plowing should be done at the same time, especially if a highly volatile chemical is being used; otherwise, large amounts of fumigant vapor will escape into the air.

BN 24003

Figure 5.—Subsurface blade applicator used for applying nematocides as an overall treatment. Chemical is sprayed from the bottom of the blade as soil passes over the blade.

BN 24000

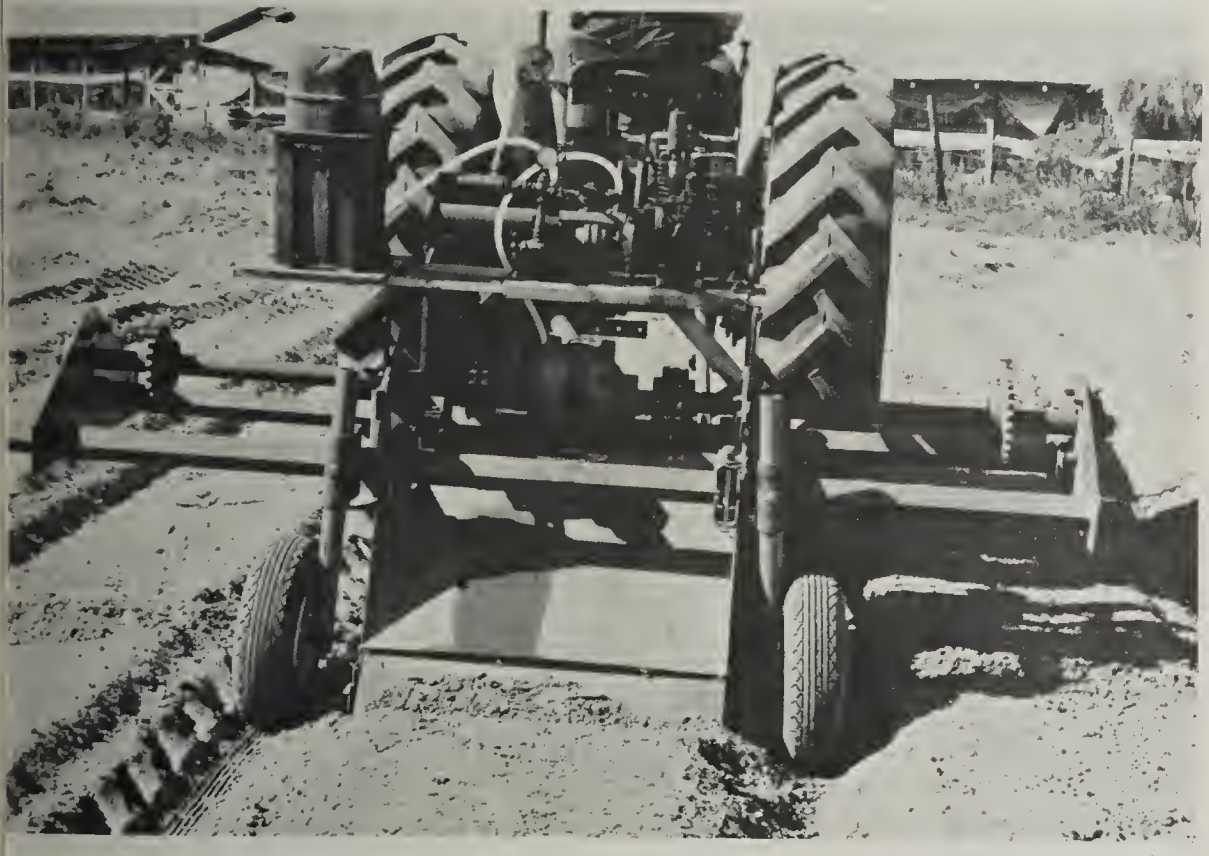
Figure 6.—Gravity-flow system for plowdown application of fumigants. Two streams of fumigant run into each furrow ahead of the covering plows. If a pressure system is used, the fumigant container can be mounted on the side or in front of the tractor.

BN 24005

Figure 7.—Fertilizer spreader modified for applying granular nematocides. The granular chisels are mounted 12 inches apart. The drag smooths and firms the soil after treatment.

Low volatility nematocides, either liquid or granular, can be mixed into the soil with disk harrows or rototillers (fig. 8). Volatile chemicals should not be applied unless the soil is to be immediately covered with polyethylene sheeting (fig. 9).

In areas where crops of high value are grown and where maximum nematode control is needed, two applications of nematocide may be practical. In such cases, the soil is treated, then plowed, then treated again. Thus surface soil, which receives little treatment the first time, is plowed under and receives its treatment on the second application. The second treatment may be combined with plowing by using a plow applicator. If possible, different nematocides should be used for each of the two applications. For example, dichloropropene might be used for the first application and



BN 23999

Figure 8.—Rototiller used to incorporate low-volatile nematocides into the soil. The nematocide is sprayed on the surface of the soil ahead of the tiller blades.

BN 24014

Figure 9.—Rototilling and covering soil with polyethylene in one operation. Nematocides are sprayed on the soil in front of the rototiller.

ethylene dibromide or dibromochloropropane for the second. This procedure reduces the chance of residues in the crop and lessens the possibility of phytotoxicity.

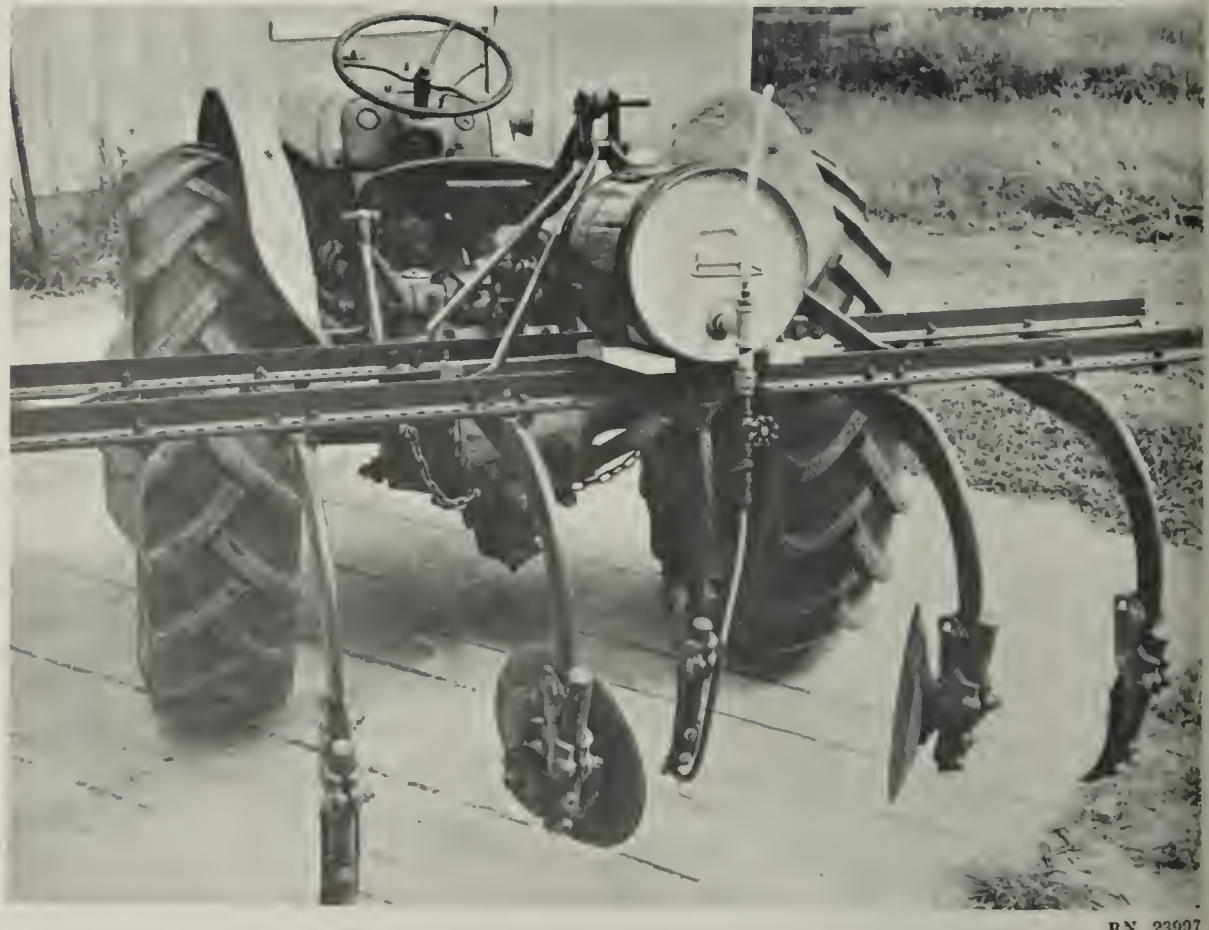
Except when polyethylene sheeting is applied, soil surfaces should be smoothed and firmed after treatment. Drags, spring-loaded soil rakes, cultipackers, and bedshapers are used for this purpose.

ROW TREATMENT

Row application of nematocides is less expensive than overall application. The commonest types of machinery used for row application are pictured in figures 10 through 13. Chemicals should be placed 6 to 12 inches deeper than the original soil surface, then covered with a listed bed of soil formed by listing plows mounted behind the fumigation chisels.

Furrow applications of nematocide are sometimes combined with application of fertilizer in the drill. The fumigant delivery tube is attached behind the fertilizer opening shovel, and the chemical is allowed to run into the furrow. Both fumigant and fertilizer are then covered with a listed bed. The disadvantage of this method is that the fumigant usually is not applied at sufficient depth for best results.

Granular nematocides can be used in granular-row applicators that have been developed for application of insecticides. The granules can be applied with a solid-fertilizer shank or behind an opening shovel as a furrow treatment. Granular nematocides also can be mixed with fertilizer that is applied in the fur-

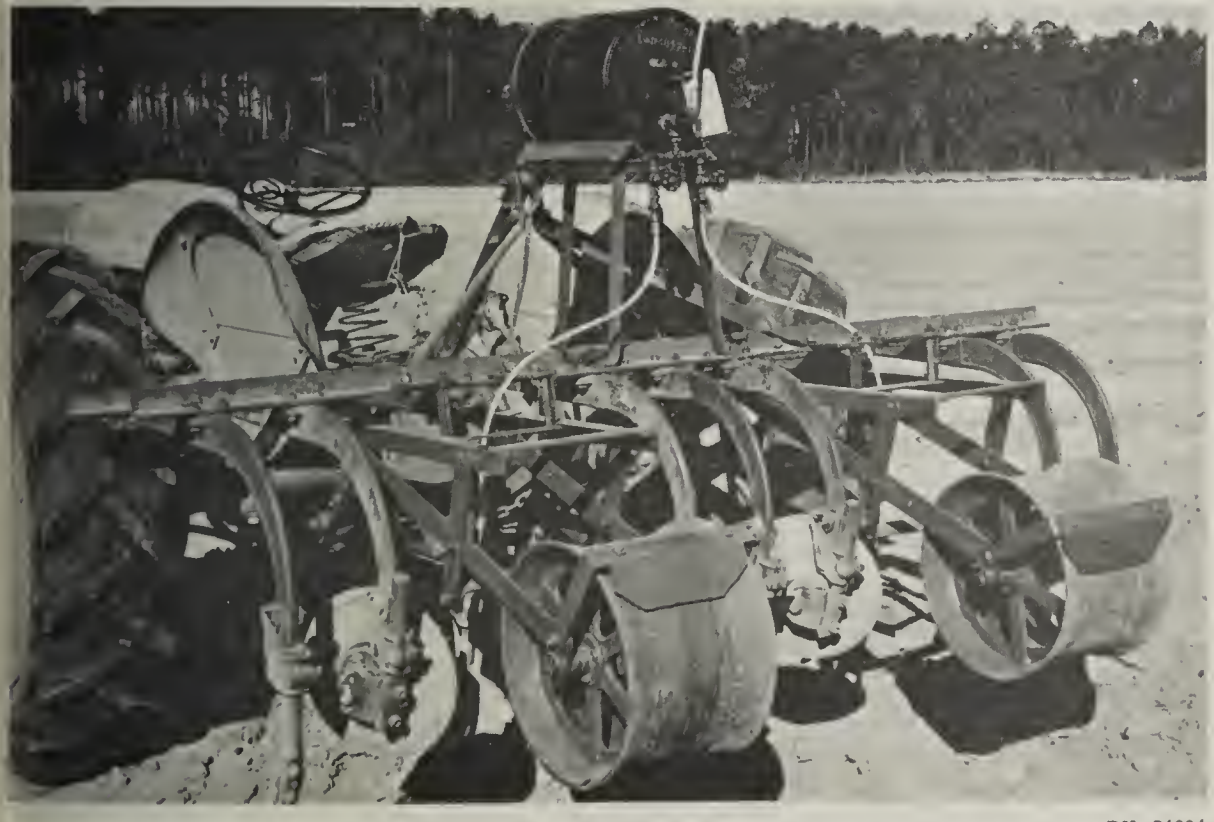


BN 23997

Figure 10.—A one-row, gravity-operated fumigant applicator. Soil is listed on the fumigant by the large disk hillers. Multiple-unit machines can be constructed to treat more than one row at a time.

BN 24008

Figure 11.—Combination plow for applying both fertilizer and nematocide. The nematocide is applied behind the shallow subsoiling chisel; the colters open a furrow in which fertilizer is applied; and the row is closed by the large disk hillers that form listed beds. Large multiple-row plows are also available.



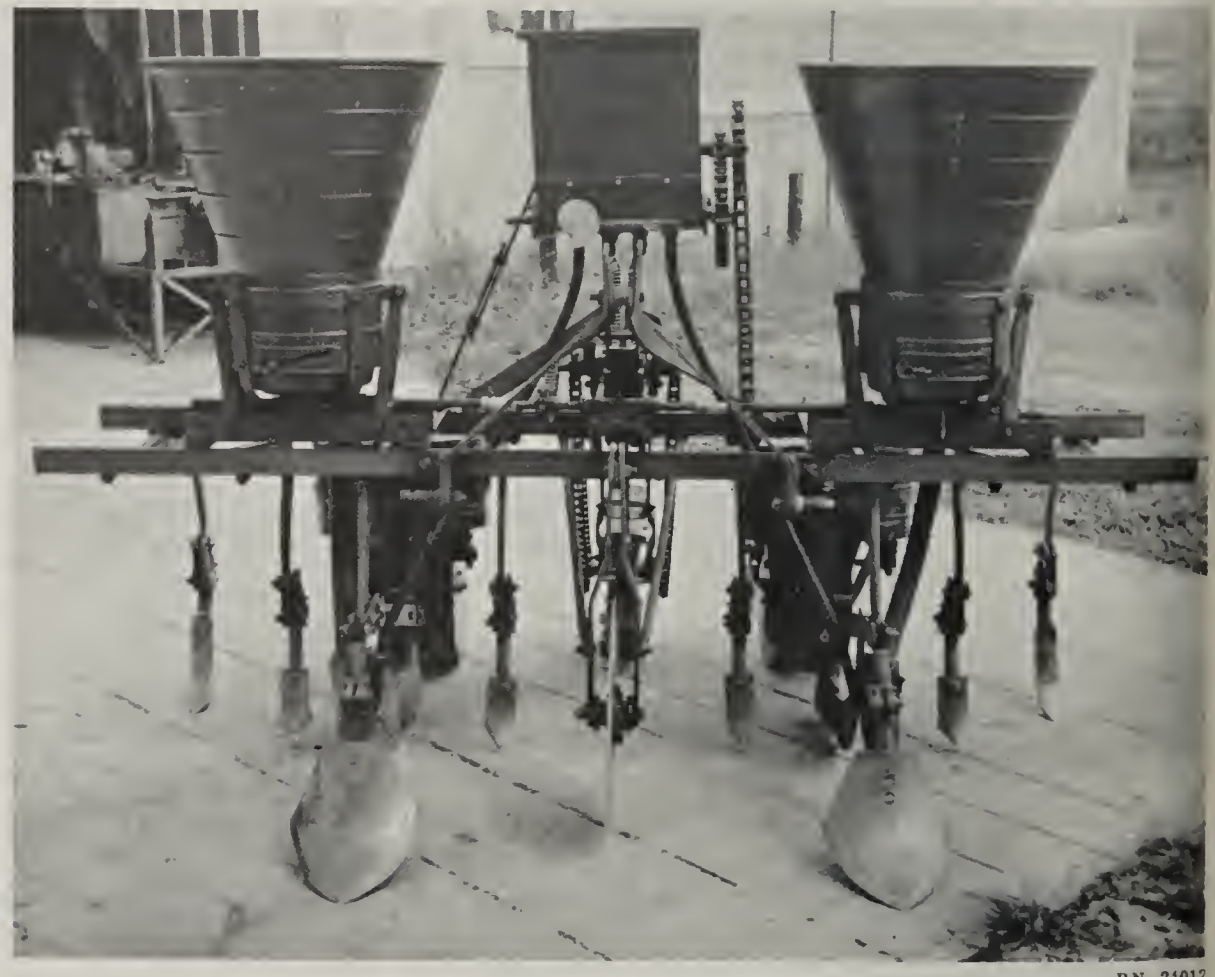
BN 24004

Figure 12.—Two-row, gravity-flow fumigant applicator that injects nematocide in the row, covers the chemical by means of the disk hillers, and firms the beds with press-wheels.

row, but this method has one distinct disadvantage: The mixture is usually applied at the depth best for fertilizer, which is too shallow for most nematocides.

A number of field and truck crops are tolerant to dibromochloropropane (DBCP). These crops can therefore be treated with DBCP during planting. When DBCP is applied as a chisel or furrow treatment at planting, the chemical should be placed at a minimum depth of 6 inches and at least 2 inches beneath the seed. Some growers prefer to place the granular formulation about 2 inches to either side and below the seed. This minimizes the possibility of injury to germinating seed. Application of dibromochloropropane during planting is generally not quite as effective as a preplant application, but operational savings usually compensate for the less effective nematode control.

Except when chemical is applied during planting, listed row-beds are used to seal volatile nematocides in the soil. The beds should be approximately 15 to 24 inches wide at the base and 8 to 12 inches higher than the original soil surface (fig. 14). After the nematocide is applied, the bed should be left undisturbed for 7 to 21 days, the period depending on the type of nematocide used and on local weather and soil conditions. The beds can be leveled before planting by any of several methods. Fertilizer can be added by side placement before the beds are leveled. V-shaped blades, built-up sweeps, boards, or opening plows and shovels can be used to scrape the top part of the bed into the middle of the row. If fertilizer is added after nematocide treat-



BN 24012

Figure 13.—**Cultivator frame equipped for applying fertilizer and granular nonphytotoxic nematocide in the furrow at planting. The nematocide is distributed from the center hopper into the furrows. The furrows are closed with soil by the scooters before seed is dropped by the planters.**

BN 24002

igure 14.—**Listed row beds following treatment by the row method. The beds should not be disturbed until planting.**

nent, beds are opened with a large ›pening shovel, fertilizer is added, nd the furrow closed with treated oil. In this case special attention nust be devoted to closing the fur-ow with only the soil that has been reated.

Nematocides of low volatility, uch as diethyl pyrazinyl phos-›horothioate, can be applied on rec-›mmended crops as a band treat-nent along the planting row. The reated band should be 10 to 16 nches wide, and the chemical should ›e mixed with the surface soil by ·ototilling or some similar stirring nethod. The chemical moves down n the soil following irrigation or ainfall.

Wide-range soil fumigants can be ıse‌d as row treatments for control ·f nematodes, weeds, and soil fungi. Some wide-range fumigants include o d i u m methyl dithiocarbamate SMDC), dimethyltetrahydro thia-liazinethione (DMTT), D-D and nethyl isothiocyanate mixture, and nixtures of methyl bromide, chloro-picrin, and propargyl bromide. Row treatments provide a sterilized band 10 to 12 inches wide along the planting site. The treated area is easily recontaminated with weed seed unless the listed bed is carefully leveled and the untreated top part of the bed scraped into the middle of the row. Soil from the middle should not be moved into the drill during the first, and possibly the second, cultivation.

In some areas there is a growing interest in furrow application of specific pesticides for control of nematodes, soil fungi, weeds, and insects. A mixture of certain nematocides, fungicides, herbicides, and insecticides can he used. Application costs are reduced when several chemicals are applied at the same time. This is usually done by applying the mixed chemicals in a furrow, with or without fertilizer. Such applications are satisfactory if the proper combination of chemicals is used.

STRIP TREATMENT

Strip treatment is a modification ·f overall treatment. Its use is imited to wide-row crops such as rchards, vineyards, groves, and ome nursery liner plantings. Most ·f the equipment, methods, and chemicals used for overall treatment can be used for strip treatment. The treated strip is usually 6 to 12 feet wide and centered on the future transplanting site. The total area treated varies from ¼ to ½ of the

land area, the area depending on the width of strips and the number of strips per acre.

The only advantage that distinguishes this method from overall application is a saving in the amount of chemical used per acre. Its chief disadvantage is the likelihood of introducing nematodes to the treated area soon after planting by movement of soil from adjacent untreated areas. However, strip treatment will usually prevent severe nematode injury for 2 or 3 years after establishment of a new orchard or vineyard.

SPOT TREATMENT

Nematode damage in fields is often restricted to well-defined spots. If surrounding areas are relatively free of nematodes, these spots can be treated individually. The plow applicator can be used for spot treatment simply by turning on the fumigant applicator when the plow passes through the infested area. Similarly, nematocides suitable for application during planting can be released as the drill moves through badly infested areas. Spots can also be treated with an overall chisel applicator, after plowing but before planting.

POSTPLANTING SIDEDRESSING TREATMENT

Whenever possible, nematode control should be undertaken before perennial crops are planted. Postplanting treatment will often restore vigor and increase yields of perennials in nurseries, orchards, citrus groves, and vineyards but it is a poor substitute for preplanting treatments. Annual crops do not usually benefit from postplanting treatment.

Dibromochloropropane (DBCP) is the most commonly used postplanting fumigant. Postplanting sidedressing treatments can be applied in liquid or granular form about 6 inches deep and to either side of plants (fig. 15). The chemical should be applied through chisels or behind an opening disk. Furrows made by the applicators must be closed with soil thrown by scooters or sweeps. If backsweep chisels are used, the furrows can be closed by a presswheel.

Nonphytotoxic nematocides also can be applied as a postplanting treatment for established trees. An offset chisel can be used to treat close to tree trunks (fig. 16). The areas between tree rows can be treated with any standard chisel applicator. The chemical should be applied as deep as possible but not shallower than 6 inches. If irrigation is available, seal the soil surface with water; this will also move water-soluble nematocides down around the roots.

DRENCH AND IRRIGATION WATER APPLICATION

Nematocides can be applied in irrigation water as soaks or drenches. To be effective, the chemical and water mixture must be carried quickly and evenly into the soil. Applying nematocides in irrigation water has been highly successful in the Western States in experimental tests on cotton, grapes, and citrus. The depth of penetration needed for nematode control may vary from as little as 6 to 12 inches for some annual crops to as much as several feet for deep-rooted crops or crops grown in areas of unusually high evaporation. The nematocide-water mixture should be applied as rapidly as possible; additional water

BN 24001

Figure 15.—One-row chisel sidedressing applicator that can be used to place nonphytotoxic nematocide on either side of plants.

BN 24015

Figure 16.—Offset chisels used for treating close to living orchard trees. The chemical is injected about 6 inches deep within inches of young trees.

should be used to wash the chemical into the soil. The nematocide can also be mixed with the full volume of water needed for flood irrigation.

If irrigation water is applied in furrows and ditches, nematocides can be metered into flowing water at standpipes, pumping stations, and other points of turbulence. Nematocides can be mixed with the water as it is shunted through centrifugal pumps and returned to the stream. It is then carried along rows quickly and evenly.

Highly volatile nematocides should not be applied through overhead sprinkler systems because large amounts of nematocide will evaporate before penetrating the soil. Low-volatility nematocides can be applied by this method if the sprinkling is continued long enough to soak the chemical into the soil to the required depth.

Fumigants such as dibromochloropropane (DBCP) and sodium methyl dithiocarbamate (SMDC) can be applied to small areas by sprinkling can or hose proportioner provided they can be soaked into the soil immediately by flooding or sprinkling.

FUMIGATING PLANT BEDS

Plant beds should be treated for nematodes, fungi, weeds, and insects. Several wide-range fumigants are available for this purpose. Procedures for applying wide-range fumigants are simple but exacting; therefore, the manufacturer's directions on dosage, exposure time, and precautionary measures should be followed carefully.

A mixture containing 98 percent of methyl bromide and 2 percent of chloropicrin is one of the most popular wide-range fumigants. Before the mixture is applied, the plant bed to be treated should be covered with polyethelene sheeting. The sheeting should be supported several inches off the ground to permit free movement of fumes under the cover. Boxes, clay pots, and bags of mulching material can be scattered on the soil to support the cover. The mulching material will thus be fumigated along with the soil.

The plastic cover should be sealed by laying the edges in a small furrow and covering with soil. Be careful not to accidentally move this untreated soil onto the treated area when the cover is removed.

The fumigant must be released in evaporation trays to keep it from soaking into the ground. One evap-

BN 24009

Figure 17.—**Methyl bromide gas being released by a Jiffy applicator under the polyethylene cover. Note that the cover is supported above ground and that all edges of the plastic are sealed with soil.**

oration tray should be used for each 100 square feet of area to be treated. The recommended amount of fumigant should be released in each tray. Gases such as methyl bromide and chloropicrin are released under the cover by means of a Jiffy applicator (fig. 17) or some other suitable device for releasing gas from its container (fig. 18).

BN 24013

Figure 18.—Homemade applicator for 1-pound cans of methyl bromide. Three nails are driven into a piece of board to support the can, and a single nail is driven through the bottom of the board to puncture the can. The applicator and evaporation tray are placed under the polyethylene just before the edges of the plastic are sealed with soil. The chemical is released under the plastic when the can is pressed down.

Some growers prefer to apply the gas from large cylinders. The amount of gas applied is regulated by placing the cylinder on platform scales. When the desired amount of chemical has been discharged, as determined by loss of weight of the cylinder, the control valve is shut off, the application line disconnected, and the cylinder moved to a new application point.

Methyl bromide and other chemicals can be injected by chisel, using tractor-drawn equipment. Equipment of this type requires less labor and chemical and is well suited to treatment of large areas. Plastic covers can be applied by hand or laid mechanically by a spreader mounted behind the chisel (figs. 19, 20).

If the plastic is laid by hand, the treated area should not be larger than can be quickly and easily covered after treatment. Lay the sheet to one side of the area to be treated, and seal one edge of the sheet in a furrow. As soon as the chemical is applied, pull the sheet across the treated area and seal all edges. The sheet should be positioned so that it can be pulled in the direction the wind is blowing. Supports are not needed under the plastic. Large fields should be treated in alternate strips. After a treated strip has been covered for 1 or 2 days, the strip of soil adjoining it can be treated. The covering on the first strip can then be loosened at both ends and along one edge, and the sheet flipped over to cover the newly treated soil.

A number of wide-range soil fumigants are available in addition to methyl bromide. Some of these include sodium methyl dithiocarbamate (SMDC) and dimethyltetrahydro thiadiazinethione (DMTT), and mixtures of D-D+methyl isothiocyanate, D - D+chloropicrin, and methyl bromide+propargyl bromide+chloropicrin.

When properly applied, these chemicals give results comparable to those of methyl bromide. They are usually less expensive and a little easier to apply than methyl bromide. They should be applied 4 to 6 inches deep with chisels mounted 6 to 10 inches apart on the tool bar of the tractor.

In case of SMDC, DMTT, and the D-D+methyl isothiocyanate mixture, sprinkling the soil surface with water after treatment gives adequate sealing protection except in the hottest weather. In many soils, if temperature is low and soil moisture high, no seal is required other than dragging and smoothing the surface after treatment. How-

BN 24011

Figure 19.—**Overall wide-range fumigant applicator that injects chemical through chisels. Pressure from the nitrogen cylinder (right) is applied to the fumigant cylinder (left). After treatment, the soil is immediately covered with the polyethylene sheet (extreme right). The edges of the sheet are sealed with soil to hold the chemical in the soil.**

ever, all of the other chemicals listed above can be covered with plastic sheeting after treatment for best results.

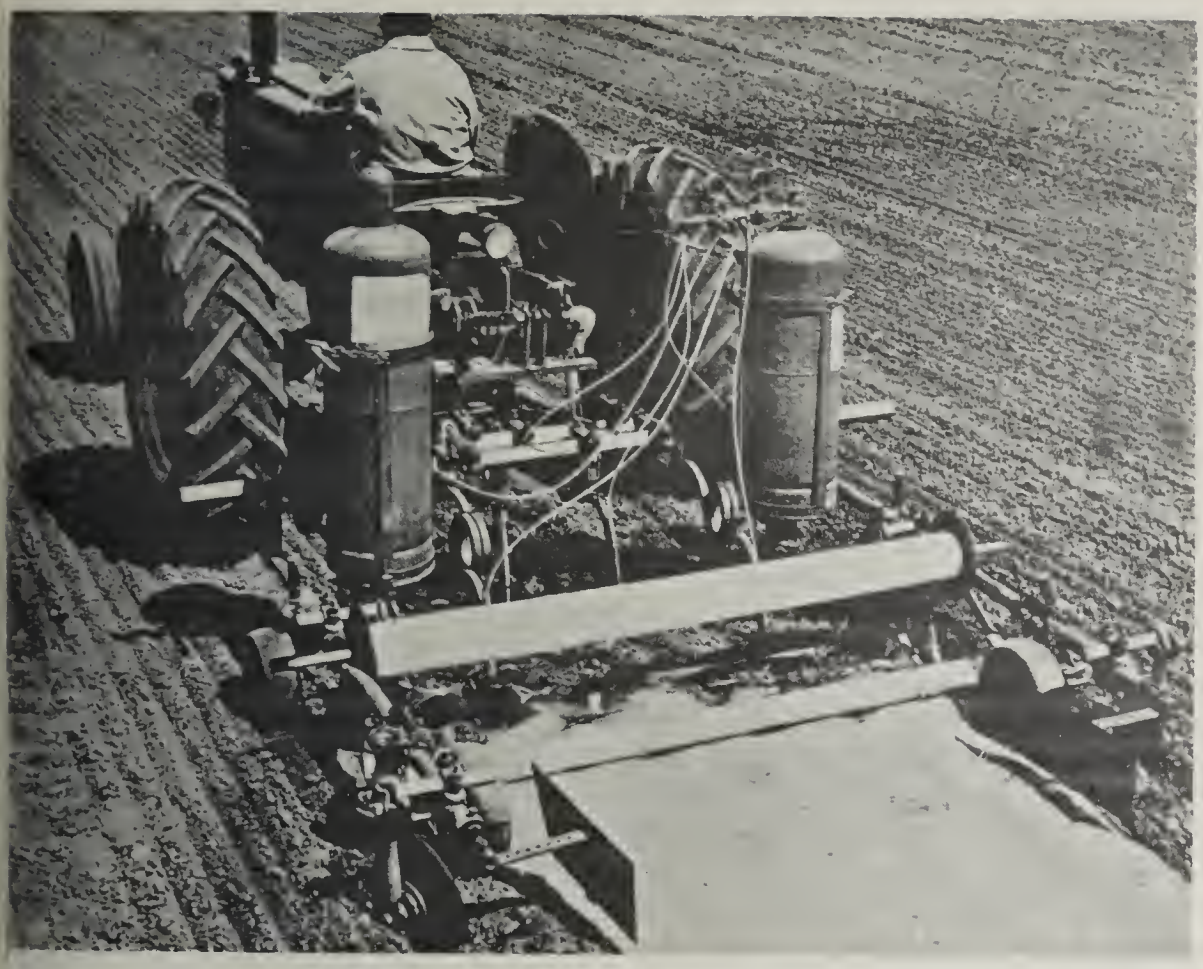
SMDC and DMTT can be mixed with water and sprinkled on the soil. After treatment, the soil should be immediately soaked with irrigation water. The treated area need not be covered with plastic sheets, although control is usually improved by this practice.

Plastic covers can be used several times if they are handled carefully, dried after each use, and stored in a dry, ratproof place. Old covers should be examined for holes before each use. Small holes can be patched with masking tape or other adhesive tapes.

TREATMENT OF POTTING AND ROOTING SOIL

Young plants that become infected with nematodes and fungi seldom thrive. Care should be taken to eliminate these pests from potting and rooting soil.

Small amounts of soil and compost material can be treated in sealed containers. Garbage cans or 55-gallon steel drums with one head removed suit the purpose. Soil should be placed in the container in 12-inch layers and fumigant applied to each layer in doses recommended by the manufacturer. Three or four inches of air space should be left at the top of the container. The container should remain tightly covered for about 7



BN 24006

'gure 20.—This overall chisel applicator injects chemicals and covers with polyethylene in one operation.

ays. Then the soil should be aer-ted. This can be done by spreading ıe soil on a plastic sheet or clean ɔncrete, to a depth of 3 or 4 inches, ı an open, well-ventilated area.

Fumigation chambers for large mounts of soil can be constructed rom concrete or wood. They ıould be less than 3 feet high and ıould contain a layer of soil 12 to 5 inches thick. Liquid chemicals ıould be poured quickly over the ɔil surface and the box sealed. asses should be applied in a plastic ıbe running through the side of the ɔx. The top of the fumigation box ıould have a rubber gasket to in-ıre a tight seal. The top can also be sealed with a piece of polyethylene held in place with masking tape or strong cord.

A simple method of treating large amounts of soil is to spread the soil on a concrete slab or a plastic sheet to a depth of 12 to 15 inches; cover it with a plastic sheet, using pots, tools or other objects to support the cover; release the chemical; and seal the edges of the sheet with soil. This untreated sealing soil should be carefully removed after treatment so as not to recontaminate the treated soil. After treatment aeration can be hastened by stirring the soil once or twice.

CONTROLLING NEMATODES IN HOME GARDENS

Nematode problems in home gar-ɛns are generally worse than in ırm land because many vegetable crops are more susceptible to nematodes than field crops. The principles used for killing nematodes in

garden soil are essentially the same as for larger fields but on a smaller scale. The expense and effort of controlling nematodes in garden soil is usually offset by good crop quality and high yields.

One of the simplest methods of controlling nematodes is to apply small quantities of nematocide in holes about 6 inches deep, at intervals spaced 12 inches apart. To insure accurate spacing of the applications, the soil surface is marked lengthwise and crosswise with a rakelike marker (made by nailing wooden teeth 12 inches apart on a wooden boom attached to a handle). The nematocide can be applied by one of several methods. The most convenient for small areas is to punch a hole 6 inches deep at each point where the marker lines intersect, place a soil fumigant capsule (usually containing ethylene dibromide) in the hole, and cover it immediately with soil.

Use of "handgun" applicators is more satisfactory for larger areas (fig. 21). The fumigant is squirted into the soil through an opening at the bottom of a probe. Several inexpensive handguns, or fumiguns, are manufactured and come complete with directions for calibration and use.

BN 23998

Figure 21.—**Application of fumigant with a handgun. Note that the soil has been marked off into a 12-inch-square grid to insure even, uniform treatment.**

The furrow method of application is convenient for treating garden soil and requires only improvised equipment. A furrow 6 to 8 inches deep is opened with a garden tractor, push plow, or hoe, and the nematocide is poured into the open furrow from a fruit jar with two nail holes punched in the lid (fig. 22).

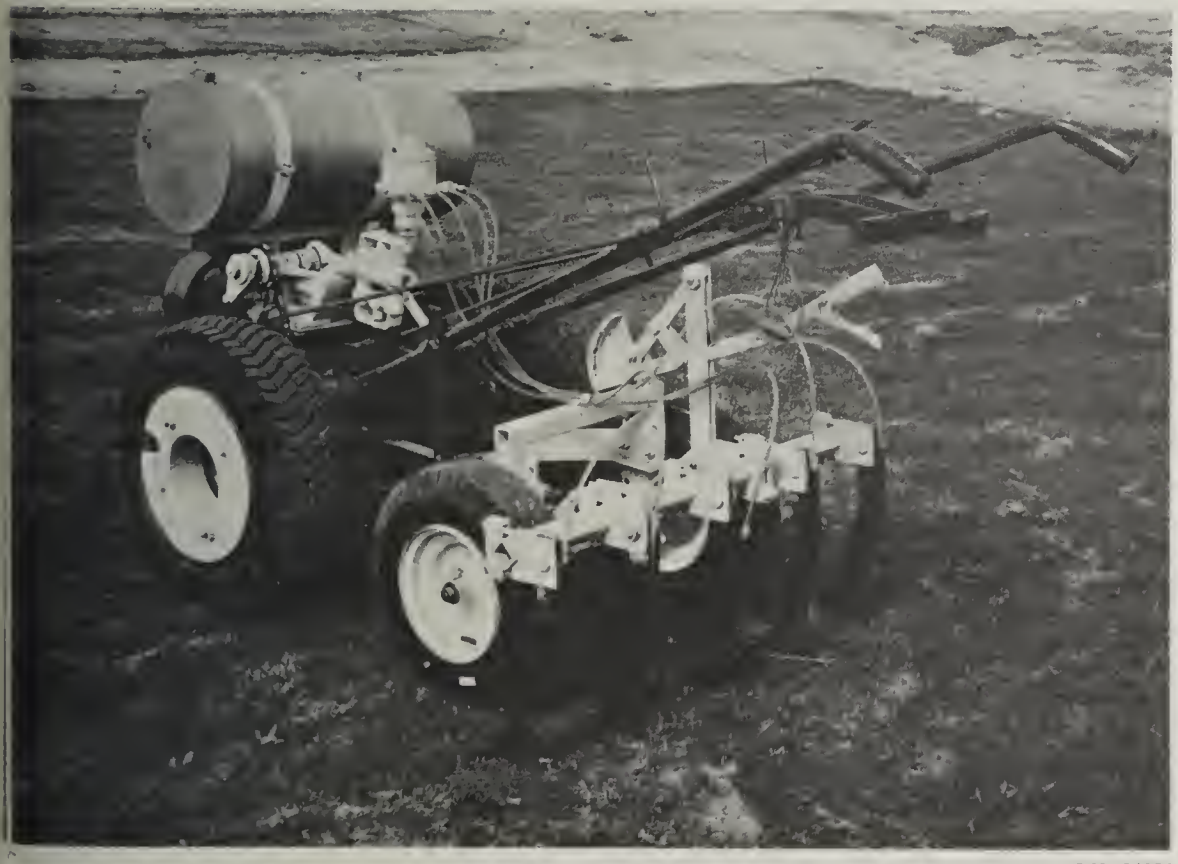
After the nematocide is placed in the bottom of the furrow it is immediately covered with soil; then a second furrow 12 inches to one side and parallel to it is opened. The application of the fumigant is repeated in this manner until the whole garden has been treated. Granular formulations of nematocides can be applied similarly in the furrow by spreading weighed amounts of granules in the bottom of the furrow. The nematocide dibromochloropropane can be easily applied as a granular formulation or mixed with fertilizer as a furrow treatment of home gardens.

Mechanical nematocide applicators can be attached to most garden tractors. Essential components are a fumigant metering device, delivery tubes, applicator frame, and small thin chisels (fig. 23). Only tractors with large wheels and at least 4 hp have sufficient power, and if additional traction is needed, wheel weights and even mud chains can be added.

Emulsifiable nematocides can be applied by drench methods. Hose proportioners can be used to regulate the amount of chemical applied in water (see "Drench and Irrigation Water Application," p. 18). The manufacturer's directions as to the amount of water applied should always be followed.

BN 24026

gure 22.—Applying a soil fumigant by pouring it from a fruit jar into a furrow. Before the fumigant is applied, the jar can be filled with a known quantity of water and the water sprinkled in the furrow to determine how much chemical will be used per row. After application of chemical, the furrow must be filled with soil immediately.



BN 24030

Fure 23.—Garden tractor modified for applying soil fumigants. A fumigant pump is driven by a chain that is geared to the driving wheels. The rear wheels regulate depth of application. The chisels are mounted 8 inches apart.

It is possible to treat garden soil by applying low-volatile nematocides on the soil surface, and by harrowing or rototilling to work the chemicals into the soil. Other chemicals, such as granular dibromochloropropane (DBCP), with low to moderate volatility, can be applied by this method, but the dosage will be at least twice that needed for furrow or chisel injection.

Whatever the method used for applying nematocides in home gardens, the soil surface should be smoothed by raking or dragging when the application is finished. Results will usually be improved by sprinkling the soil surface with water immediately after raking. This helps hold the chemical in the soil the length of time needed for nematode control.

TREATING LAWNS, SHRUBS, AND TREES IN HOME YARDS

In areas where nematodes are known to be a problem, nematocides should be applied before lawns, trees, or shrubs are planted. This insures establishment of healthy, quick-growing plants.

If existing trees or ornamentals become infected, they can be treated with nonphytotoxic nematocides such as dibromochloropropane (DBCP) or dichlorophenyl diethyl phosphorothioate (V–C 13). First, old mulches should be raked away and destroyed. Then an earth dam should be constructed around the plant. Nonphytotoxic nematocide should be mixed as directed and poured around the plant. Then the dam should be filled with enough water to soak the chemical into the soil at least 12 inches deep. Finally, the soil should be covered with fresh mulching material.

Infected plants can also be treated with a handgun or by punching holes into the soil around the plant and adding the recommended dosage of fumigant. In either case injections should be at 12-inch intervals. After injection, the soil should be sealed with a small amount of water.

Plants nearly dead from nematode damage should be dug up and destroyed. The site can then be fumigated and replanted with a nematode-free plant.

Lawns can be treated with a hose proportioner or sprinkling can. The nematocide should be applied to an area no larger than can be conveniently sprinkled immediately after treatment. Otherwise, most of the chemical may evaporate before it soaks into the soil. The soil should be soaked until wet at least 6 inches deep.

SUPPLEMENTARY MANAGEMENT PRACTICES

Good soil management helps control nematodes and reduces the need for frequent nematocide treatment.

Crop rotation is the most effective management practice that can be used against nematodes. Nematode-resistant crops should be grown as frequently as possible to prevent nematode increase. Susceptible crops should not be grown year after year on the same land.

Since nematodes continue to multiply in plant roots after harvest of many crops, it is a good practice to plow roots out of the ground and leave them exposed to the sun and wind for several days. This kills nematodes by desiccation.

Summer fallow is sometimes used as a means of controlling nematodes. If the land is kept weed free by harrowing or using nonselective herbicides, the nematodes will gradually die of starvation. However, this method may be as costly as use of nematocides. It reduces soil

ganic matter, and does not per-anently rid the soil of all types of arasitic nematodes.

In the Western deserts, nema-des can be contolled by withhold-g irrigation water and not plant-g crops for a single year.

Increasing organic matter in the il often helps reduce nematodes encouraging predatory, para-tic, and competitive soil orga-nisms. Nematode-resistant cover crops are excellent for this purpose.

Farmers should make every effort to avoid introducing or spreading nematodes. Nematode infestation can be confined if care is taken not to transport infested soil or plant material from one field to another. All plant materials purchased, whether for farm, yard, or garden, shoud be certified free of nematodes.

CHEMICAL RESIDUES AND PLANT TOLERANCES

Chemical residues from nemato-des may remain in the soil for arying periods, the period depend-g on the type of chemical and the pe of soil. In some cases, these sidues can be assimilated by ants. The Food and Drug Ad-inistration determines residue lerance levels—that is, the amount f residue that a food or fiber may ntain without risk of injury to e consumer. Tolerance levels are eriodically summarized in the U.S. epartment of Agriculture's "Sum-ary of Registered Agricultural esticide Chemical Uses."

Nematocides such as ethylene di-romide, methyl bromide, and di-romochloropropane leave appreci-ble amounts of bromine residues in e soil. Bromine residues are toxic some plants and are taken up by hers. Onions, for example, are xtremely sensitive to bromide resi-ue. Forage and feed crops take up romine and sometimes cause illegal vels of bromine in the milk of airy animals.

Dibromochloropropane (DBCP) auses severe damage to tobacco, otatoes, sweetpotatoes, garlic, and me types of pepper.

Nematocides such as tetrachloro-iophene, chloropicrin, and di-loropropane tend to raise the chlorine content of soil, but when they are used according to direc-tions they do not cause excessive levels of chlorine in edible portions of plants. Tobacco treated with chlorine compounds frequently has a large amount of chlorine in the leaves; this causes poor burning quality.

Under some soil conditions, nema-tocides may upset microbiological relationships that affect soil fertil-ity. Soil nitrification processes can be delayed for as long as 12 weeks in cool, wet soils with low pH and poor nitrifying capacity. This nitrification lag is associated with high levels of ammonia-nitrogen, which is toxic to some plants, and with low nitrate-nitrogen, which causes nitrate deficiency in many plants. Use of nematocides, par-ticularly soil sterilants, on alkaline soils may cause a phosphorous defi-ciency in some plants.

Under normal conditions of use, nematocides present no serious hazard as long as the manufacturer's directions and State experiment station recommendations are fol-lowed. The label on the nematocide container gives dosages, conditions of use, and crops approved for treat-ment by the U.S. Department of Agriculture.

USEFUL INFORMATION

APPROXIMATE NUMBER OF FEET OF ROW PER ACRE AT GIVEN DISTANCE

Distance between rows (inches)	*Feet of row per acre*
12	[1] 43, 560
18	29, 010
24	21, 758
30	17, 427
36	14, 526
42	12, 439
48	10, 853
54	9, 684
60	8, 714
72	7, 263

[1] One acre equals 43,560 square feet.

TRACTOR SPEED CONVERSIONS

Miles per hour	*Feet per minute*	*Seconds per 100 feet*
2	176	34
2½	220	27
3	264	23
3½	308	20
4	352	17
5	440	14

PERCENTAGE SOLUTION

Percent	*Dilution or rates*	*P.p.m.*	*Grams per liter*
1. 0	1:100	10, 000	10. 0
0. 1	1:1, 000	1, 000	1. 0
0. 01	1:10, 000	100	0. 1
0. 001	1:100, 000	10	0. 01
0. 0001	1:1, 000, 000	1	0. 001

SOLID MEASURE

U.S. Measure Converted to Metric System

1.0 pound =16 ounces =453.59 grams
0.06 pound =1 ounce =28.35 grams
0.04 ounce=1.0 gram

LIQUID MEASURE

U.S. Measure Converted to Metric System

1 gallon	=4 quarts	=3785 ml. (cc)
1 quart	=2 pints (32 fl. ounces)	=946 ml.
1 pint	=2 cups (16 fl. ounces)	=473 ml.
1 cup	=16 tablespoons (8 fl. ounces)	=236 ml.
2 tablespoons	=6 teaspoons (1 fl. ounce)	=30 ml.
1 tablespoon	=3 teaspoons (½ fl. ounce)	=15 ml.
1 teaspoon		=5 ml.

0.87 ml. per square foot=10 gallons per acre for area application

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Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

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AERIAL APPLICATION

of Agricultural Chemicals

AGRICULTURE HANDBOOK NO. 287

U.S. DEPARTMENT OF AGRICULTURE

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CONTENTS

	PAGE
Equipment	3
Aircraft	3
Application equipment	4
Mixing equipment	15
Loading equipment	17
Application	19
Pilot	19
Application methods	21
Deposit pattern and swath spacing	26
Protection and storage of chemicals	30
Safe disposal of containers and chemicals	30
Empty containers	31
Surplus chemicals	33
Regulations	33
Pesticide products	33
Residue tolerances	35
Application laws	37
Chemicals	37
Classes	37
Formulations	43
Selection	44
Rate of application	46
Limitation or restriction	47

This handbook contains some information formerly in Farmers' Bulletin 2062, "How To Spray The Aircraft Way."

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Prepared by

Agricultural Research Service

Washington, D.C. Issued May 1965

AERIAL APPLICATION of Agricultural Chemicals

This handbook has two uses—a textbook in training agricultural aircraft pilots and a reference guide for aerial application operators.

Regulations and even methods in this relatively new industry vary widely in the different States, but the basic requirements for safe and effective work apply equally in all areas. Aerial applicators will better serve the interests of agriculture if they are well informed. Certainly, operators who know how to handle agricultural chemicals safely and usefully will be less likely to have trouble.

Broad recommendations that apply generally often need to be modified to meet local situations. Therefore, for the solution of your special problem, draw freely on the advice of your county agricultural agent and State experiment station.

EQUIPMENT

Aircraft

When you are planning to buy a new aircraft for aerial application, select the type best suited to perform the major part of the anticipated work. Do not consider only the price; do not buy another type originally designed for other purposes merely because it is readily available at nominal cost.

Incorporated into aircraft designed specifically for aerial application are many features to enhance the safety of the pilot, increase the versatility of the aircraft, and improve the efficiency of operations. Features you should look for are:

- Design that emphasizes pilot comfort to reduce fatigue.
- Special ventilation to avoid pilot exposure to agricultural chemicals.
- Good visibility in all directions.
- High performance with gross loads.
- Ease of control during slow flight.
- Partial aileron control during stalls.
- Load placed forward of the pilot.
- Special fuselage design that allows progressive collapse in an accident and includes a 40–G cockpit that will fall outward.
- Sturdy structure for protection in a turnover.
- Shoulder harness that hooks to an inertia reel to allow free movement.
- Landing gear equipped with wire cutters.
- Cable to deflect wires over the tail.
- Large removable panels to allow easy cleaning, inspection, maintenance, and repair.

- Corrosion-resistant hoppers and other components.
- Treated structures to resist chemical corrosion.
- Quick-change dispersal apparatus to apply either dry materials or liquids.
- Adjustable dispersal apparatus that can produce a wide range of droplet sizes, deposit patterns, and application rates.

Application Equipment

SPRAYS

Tanks

Size and location.—Use a tank that is large enough to hold a full load and have enough space remaining to allow for foaming. Locate it as close as possible to the center of gravity and anchor it securely to the main structure of the fuselage. Install baffles to reduce sloshing and to add strength to the tank.

Shape.—The shape of the tank should be such that it will drain completely in flight and on the ground. Materials that cannot be drained in flight remain as ballast that reduces aircraft performance unnecessarily.

Install a valve in the low point of the tank to help in calibration and to allow purging it when you change to another agricultural chemical. A tank that can be drained completely when the aircraft is parked greatly simplifies calibration of the spray system, especially when you use low-volume application rates.

Material.—The tank should be built of or lined with a material resistant to agricultural chemicals. Materials that rust or corrode may cause leakage problems or plug screens or nozzles.

Filler.—Bottom-filling attachments are preferable. A large opening in the top of the tank also is desirable because it provides a convenient entry for cleaning the tank interior. It should be large enough to allow filling from a 5-gallon can or bucket without a funnel.

Include a large fine-mesh screen in the filler to catch sediment. The screen is especially desirable if water from ponds, reservoirs, or ditches is used for mixing. Set the screen down into the tank to prevent splashing or flooding.

Agitator.—When you spray wettable powders that require agitation, recirculation during ferry to the worksite and during turnarounds usually will suffice. Design the recirculation system so that the return flow will wash the bottom of the tank.

Air vent.—A large air vent is required to assure uniform flow during spraying and to prevent tank collapse or reduced flow when jettisoning a load. A large spring-loaded flapper valve is satisfactory, but a preferred vent is a tube in the top of the tank, projecting upward a few inches, then curving downward and out through the bottom of the fuselage. This type of vent confines accidental overflow during loading, so chemicals fall free of the aircraft without contaminating the cockpit or loading crew. It also keeps the chemicals away from the pilot during application maneuvers.

Gage.—It is desirable to have a spray tank quantity gage in the aircraft. It should be accurate in flight and when the aircraft is parked. Some chemicals applied by aircraft cannot be metered; nor is it always possible to accurately measure the quantity loaded into the aircraft each time from large mixing facilities. You can use the gage in the aircraft for this measuring.

The pilot can use a gage that is accurate in flight to check on the calibration. For example, as the spraying progresses, he can check the quantity applied on one or more swaths, to each field, or several fields. If the quantity used is too little or too great, he can make an immediate adjustment before continuing with the application.

Pumps

A pump in the spray system is necessary to insure uniform and proper flow rates at all times, to assist in producing the desired atomization, and to keep wettable powders in suspension.

A centrifugal pump is preferred by most operators because it is available in many sizes, handles all kinds of spray chemicals with minimum wear, produces pressures up to 70 pounds per square inch, and can be operated without a relief valve. Mount a centrifugal pump lower than the bottom of the spray tank so that it will be self-priming and will not lose its prime during spraying.

Carefully consider the size of the pump when equipping an aircraft. A pump with too little capacity will require reducing the swath spacing to assure adequate deposit on the crop. This increases the amount of flying needed to complete a job and reduces efficiency. A centrifugal pump with a pumping capacity considerably greater than required often has trouble because the impeller cavitates. When this occurs, air gets into the system and calibration becomes erratic. You should install an air bleed line in the high point of the impeller section to insure full and positive flow at all times. This line should return to the top of the spray tank.

A rotary-gear pump is positive displacing, self-priming, and capable of producing pressures up to 200 pounds per square inch. A pressure-relief valve or bypass must be incorporated into the spray system to relieve the pressure or bypass the chemical when the spray valve is turned off. Do not use a rotary-gear pump for applying wettable-powder suspensions, because such suspensions usually wear the teeth and sidewalls and may cause the pump to seize.

Pump Power Sources

Power sources used to drive spray pumps include windmills, hydraulic motors, electric motors, belt or gear drive off the aircraft engine accessory section, and, on large aircraft, gasoline engines.

Windmills are by far the most common power source, and many kinds are available. They may be made of wood, metal, or plastic. The number of blades ranges from two to six. Some have adjustable blades to allow variation in pump

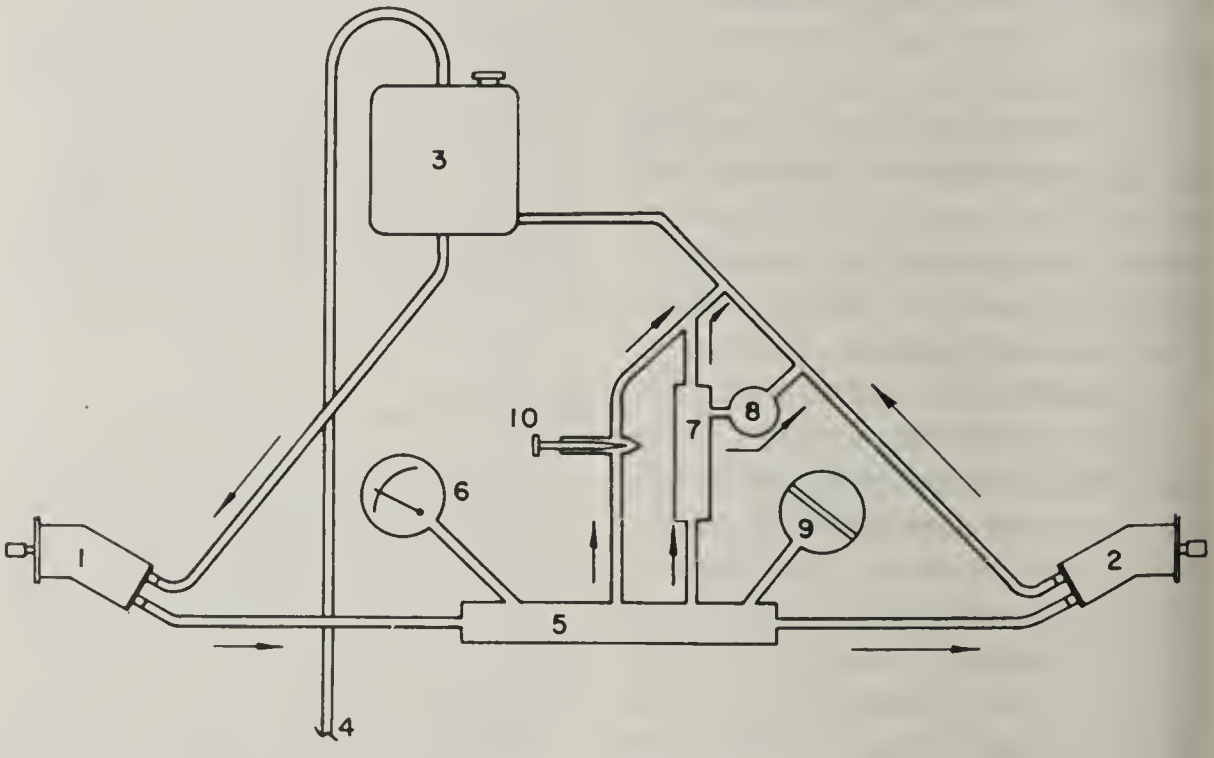
speed or to compensate for the difference in operating speeds when used on different aircraft types. Some have full-feathering blades so that the pump can be stopped without a brake. When selecting a windmill, give consideration to the type that will turn the pump at its most efficient speed during normal operations.

Equip the windmill propeller with a brake so that the pilot can stop the pump when the spray valve fails to cut off. Stopping the pump saves pump wear and may save the pump and its attachments if a blade is thrown or damaged.

Hydraulic drive is often used on larger aircraft on which a windmill may be difficult to attach. Hydraulic motors develop considerable power. You can install them inside the aircraft, thus eliminating the parasitic drag caused by external drive systems. Hydraulic drives are used on smaller aircraft when considerable power is needed or when it is desirable to keep as much of the spray installation as possible inside the aircraft.

Other power sources—electric motors, power takeoffs, and gasoline engines—to drive spray pumps are quite limited in use.

On airplanes that are operated at 90 miles per hour or faster, an electric drive system that develops sufficient power to apply 1 gallon per acre is rather heavy and causes a considerable load on the electrical



HYDRAULIC DRIVE SYSTEM

1. Hydraulic pump. 2. Hydraulic motor. 3. Reservoir, 2-gallon capacity. 4. Vent; should be routed through belly. 5. Manifold. 6. Pressure gage; may be attached while adjusting relief valve. 7. Pressure relief and unloader valve, 900 pounds per square inch. 8. On-off valve; can be controlled from cockpit. 9. Accumulator—50 to 60 pounds of air pressure per square inch. 10. Speed-control valve is a sharp-needle valve; can be controlled from cockpit if it is desirable to regulate motor speed.

system; however, on slower aircraft and with lighter application rates, electric drives have been satisfactory.

A power takeoff system is also heavy, especially when equipped with a clutch so that the pump can be stopped.

Gasoline engines are often used to drive spray pumps installed in large aircraft, especially when it is necessary to pump more than 100 gallons per minute. Carefully select the type to be installed. Use an engine and pump combination that is manufactured as a unit. The manufactured pump-engine units usually are engineered to provide many years of trouble-free service.

Install a switch to stop the engine within convenient reach of the pilot (or copilot) while he is seated in the cockpit. Provide a throttle so that the pilot (or copilot) can control the speed of the pump engine during flight. A self-starter on the engine, controllable from the cockpit, is desirable, especially when the engine is located where a crewmember cannot reach it during flight.

For increased safety, ventilate the area around the engine to avoid accumulation of fumes and to assure adequate cooling of the engine. Route the exhaust pipe to the outside and well clear of any parts that may be damaged by heat. Pipe gasoline overflow from the tank or carburetor to the outside to fall clear of the aircraft. Connect the pump to the spray system with flexible connections to eliminate line breakage caused by engine and other vibration.

Screens

Incorporate a screen in the spray installation. This screen should be big enough to insure unrestricted flow when the spray system is delivering its maximum output. Locate it between the tank and pump, especially on rotary-gear pump installations, to protect the gears of the pump. If the screen is located elsewhere, it should precede the on-off valve so that foreign material will not scar the valve surfaces and cause it to leak. Include another valve, so that the screen can be cleaned without draining the spray tank.

Keep available several screen sizes to use for specific purposes. When the spray is to be finely atomized and the orifice in each nozzle is tiny, use a fine-mesh screen. If you use coarser droplets and larger nozzle orifices, you can use coarser screens.

Each nozzle also should have a screen in it so that the orifice will not become plugged.

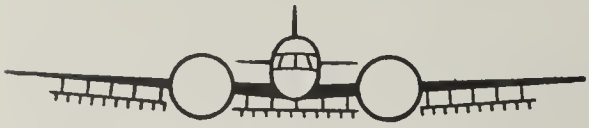
Clean all screens frequently. This is especially important when water from ponds, streams, or lakes has been used in mixing, or when chemicals have been mixed in open containers.

Dispersal Equipment

Boom and nozzle.—This is the most common system used, because of its many advantages. You can produce a large variety of deposit patterns by shifting location of the nozzles on the boom. Different droplet sizes can be produced by changing the size and type of orifice

Biplanes of the AgCat type.

Monoplanes of the Pawnee type.



Multiengine planes, like the Douglas DC–3.

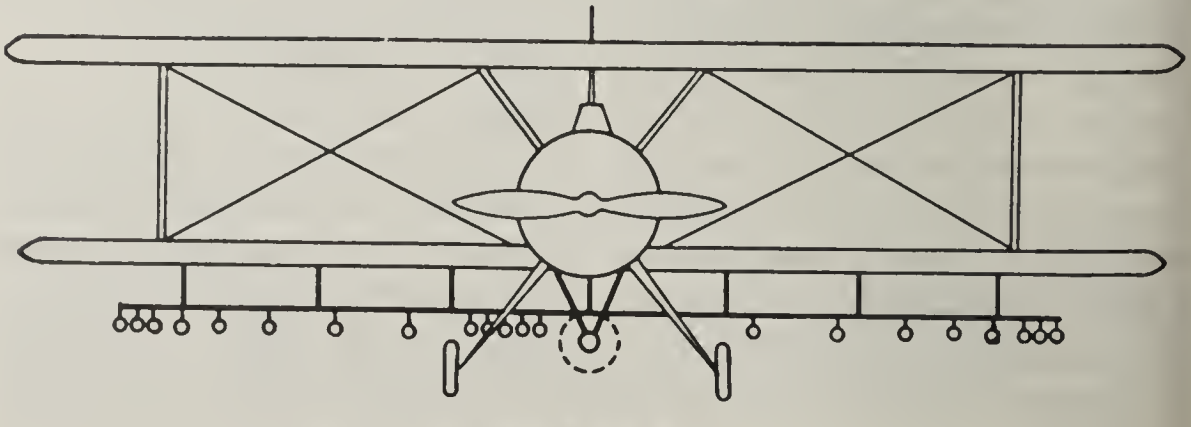
Rotary-wing craft—the helicopters.

in each nozzle, the core in each nozzle, the direction of the nozzle in relation to the airstream, and the pump pressure.

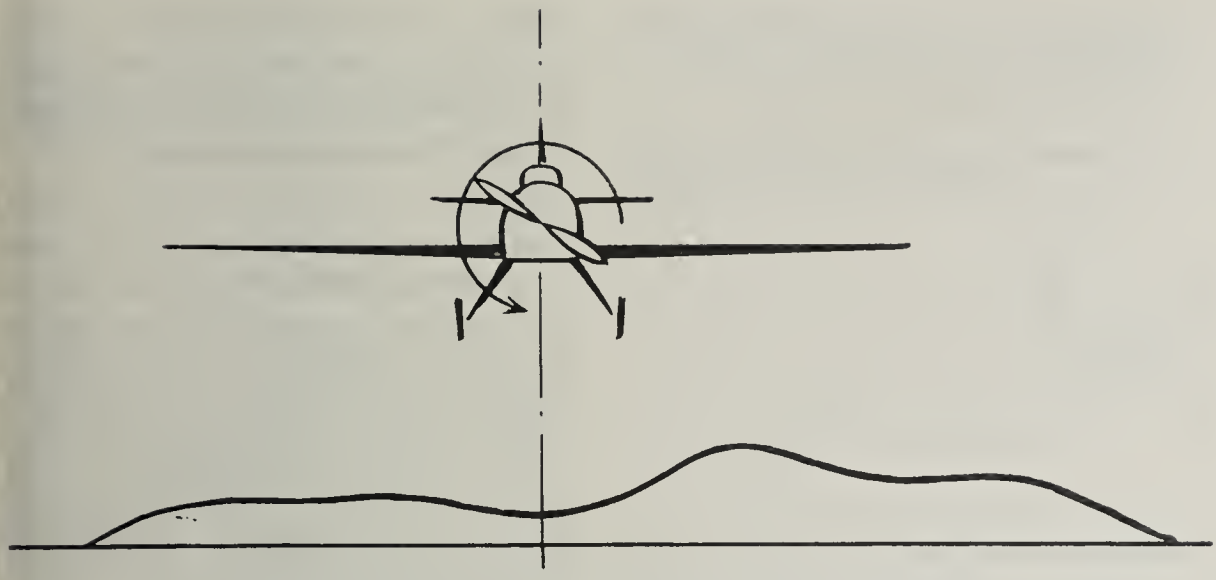
In most planes, the pilot can see the boom if it is located 3 or 4 inches behind the trailing edge of the wing (lower wing of a biplane). Therefore, he can see whether all nozzles are functioning properly during spraying and whether any are leaking or dribbling when the spray is shut off. A boom in this location creates little drag and practically eliminates the risk of snagging it on brush or tall weeds.

The boom also may be located about a foot below the wing of a biplane or low-wing monoplane or inside the wing with a pipe extended down out of the wing at each nozzle location.

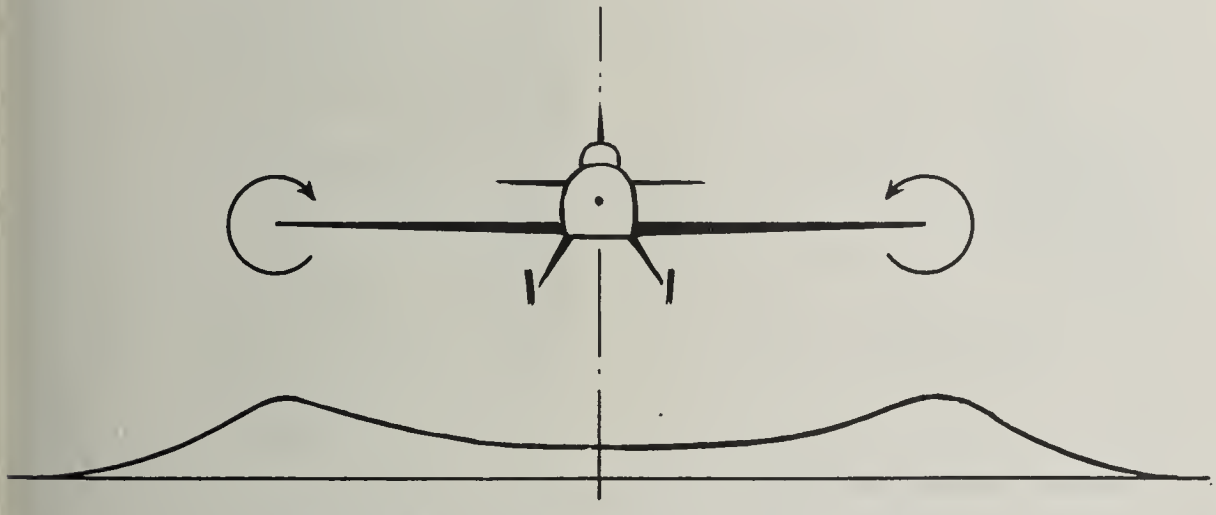
For spraying that is done 1 to 10 feet above the crop, you can use a boom approximately three-fourths as long as the wingspan. In fact, if the boom is much longer than that, too much spray may get into the wingtip vortices and spoil the swath pattern. In spacing the nozzles for spraying from this height, group a few nozzles close together 3 or 4 feet to the right of the aircraft centerline. Place no nozzles in the area 3 or 4 feet left of center. This is to unify the deposit in the center of the swath that would otherwise be distorted by the propeller vortex. From these points outward, space nozzles progressively closer together as the boom tips are approached. For applications from a greater height, you can space nozzles uniformly throughout the boom length.



Nozzle spacing.



Deposit tendency: Pattern distorted by propeller airstream.

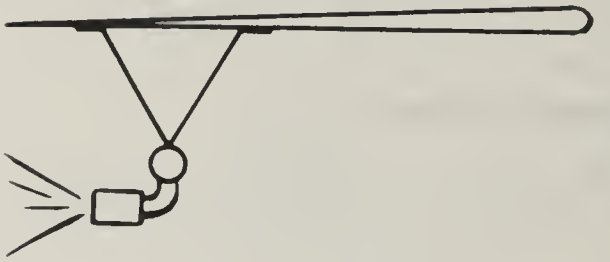


Deposit tendency: Excessive spray in wingtip vortices.

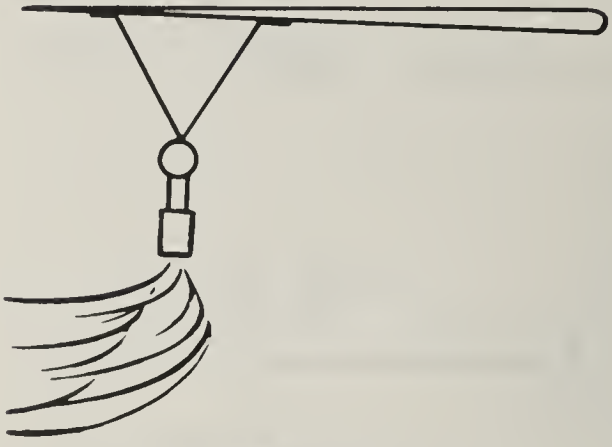
When the material to be sprayed is a type that requires reducing drift to a minimum, limit the nozzle span so that the outboard nozzles are no farther apart than about two-thirds of the wingspan. This will greatly reduce the amount of spray that is picked up in the wingtip vortices.

Droplet sizes can be varied in a number of ways; one way is to change the orifice in each nozzle. Pump pressure can be used to vary droplet sizes to some extent—increasing pressure reduces droplet size and reducing pressure increases droplet size. In addition, droplet size can be varied by changing the direction of the nozzle orifice in relation to the airstream. For example, when the same orifice and pump pressure are used, the coarsest droplets can be made by aiming the orifice straight back; somewhat smaller droplets can be made by aiming the orifice straight downward; and the finest droplets can be made by aiming the orifice forward and downward at about 45°. Do not aim the orifice forward and downward at less than 45°, because aiming it more directly into the air-

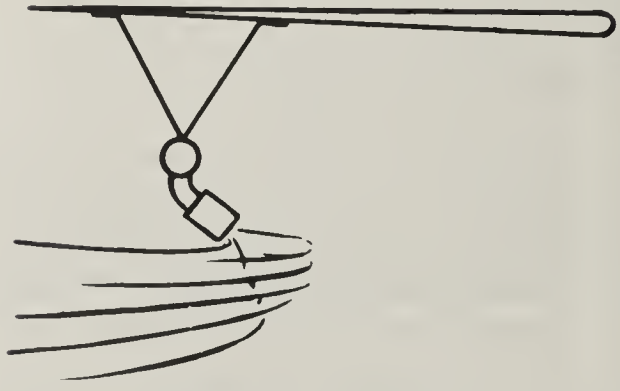
Droplet size can be varied by changing the direction of the nozzle orifice in relation to the airstream.



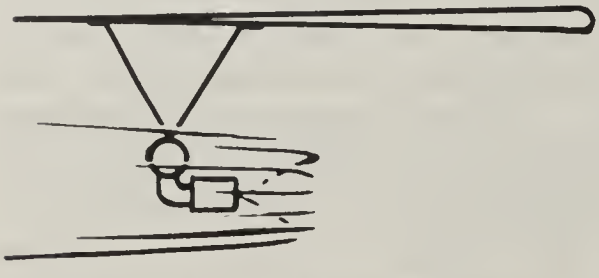
This for coarsest droplets.



This for medium droplets.



This for finest droplets.



Not this (spray collects on structure).

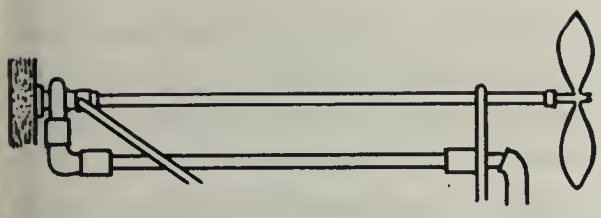
stream will cause some of the spray to collect on the body of the nozzle or attachments and fall in large drops. This wastes materials.

When attaching booms and nozzles, it is important to position them so that spray will not strike the aircraft, any of its structure, or the boom attachments. If the spray strikes any of these, it will collect and fall off in large drops, and thus waste materials. In addition to this waste, some chemicals will corrode the surfaces of the aircraft.

To insure rapid filling of the boom, immediate flow from each nozzle, and quick and positive cut-off, install a bleed line in each end of the boom. Attach the other end of the bleed line to the top of the spray tank. With the assurance that there will be an immediate full flow from each nozzle, you will not need to prime the spray system on the way to the field to be treated. It is such incidents as priming spray systems on the way to the worksite, draining the system on return to the airstrip, and leakage that cause criticism of aerial applicators. When spray is released during ferrying, the pilot often does not know whether it will fall harmlessly or into a sensitive area.

Rotating devices.—Some operators use rotating devices in preference to booms and nozzles. These are better suited for spraying a liquid with a high sediment content or one that is especially thick and gooey. Generally, the droplets are more uniform.

Several types of rotating devices are used—screens, disks, and brushes. Spray liquid flows to the



Spinning brush dispersal system.

center of the unit and sprays out by centrifugal force. Droplet sizes are varied by rotating the device faster to decrease droplet size and slower to increase droplet size. Rotation speed is controlled by adjusting the pitch of the drive propeller. You also can vary droplet size by changing screen or wire brush size—the finer the screen or wire brush, the finer the droplets.

While the rotating disk and brush installations usually use a gravity-flow system, most rotating screen installations use a pump. A pump assures uniform flow at all times. It also permits installing the dispersal unit at a location higher than the low point of the spray tank.

When only two rotating devices are installed on an aircraft, it may be necessary to fly at least 25 feet high to permit the spray to fill in the center and produce a uniform deposit pattern. Uniformity depends also on how fine the spray is and how wide apart the two units are mounted on the aircraft. For low-level work, usually four or more dispersal units are required to provide swath uniformity.

Dual-spray system.—Invert emulsions, often used with weed-killers, can be applied by using a dual-spray system. One tank is provided for oil and chemical and one tank for water. Two pumps, one for each liquid, and two booms running parallel are used. The booms are connected by mixing nozzles. Mixing, forming, and dispersing the materials take place at the nozzle where the oil and water systems converge. The droplets are usually coarser and drift less than in sprays produced by the other systems. Thus, this method is useful where drift must be held to a minimum.

You also can apply invert emulsions with a horizontally mounted, hollow spinning disk that has nozzles at the circumference.

Flow Controls

Plumbing.—Aluminum or stainless-steel tubing is preferred for most installations. The inside of common steel or iron tubing usually rusts or corrodes from chemical use, especially when the aircraft stands idle for several months. Unless common steel or iron tubing is thoroughly cleaned with steel rotary brushes before reuse, flakes of rust and corrosion deposits will break loose and plug nozzle screens and nozzles.

Hoses are less likely to blow off if the ends of tubes are beaded. Keep lines as clear of sharp bends as possible. Be sure they are large enough to carry the maximum anticipated output. Use chemical-resistant hoses and change them as soon as swelling or cracking of the surface appears. Use good-quality hose clamps.

Valves.—Use a positive-cutoff valve to eliminate dribbling when shutting off the spray at the end of the runs or when flying over pastures, ponds, lakes, streams, or other

PRECAUTIONS

It is extremely important to prevent unintentional escape of agricultural chemicals from the spray system. Leakage inside the fuselage may cause corrosion or may come in contact with the pilot. If the chemicals used are highly toxic to man or give off poisonous fumes, they can be extremely dangerous. Leakage outside the aircraft may contaminate pastures, crops, water, and other sensitive areas. Inspect the entire spray system frequently; replace bad hoses; repair cracked or loose fittings; find and correct chafing points; clean screens and nozzles; check pump seals and stop mechanisms. Keep system clean.

After you use material in suspension, flush and thoroughly clean the spray system to make certain all settlings are removed. After you use weedkillers, neutralize the system with household ammonia and clean and rinse thoroughly before applying insecticides; be particularly careful in rinsing if the crop to be treated is one that is sensitive to weedkillers. Whenever you clean or flush an aircraft and its dispersal apparatus, be careful that drainage or runoff will not contaminate any reservoirs, ponds, streams, grazing areas, or other sensitive areas.

areas that must not be sprayed. A valve that incorporates the suckback feature also reduces the risk of dribbling nozzles.

Locate the handle that controls the on-off valve near the throttle so that the pilot can operate both conveniently. The preferred method is to move the handle forward to turn it on.

Equip each nozzle with a check valve to keep the nozzle from dribbling when the spray is shut off. Clean these check valves frequently and regularly. If you use the diaphragm type, change diaphragms at regular intervals.

When a positive-displacement pump is installed in the spray system, you must use a pressure-relief or bypass valve. The valve is also useful for making fine pressure adjustments when calibrating the spray system.

DRY MATERIALS

Hopper

Size.—The hopper should be large enough to be filled to capacity without having to level the materials or push them forward or into corners. When this is necessary to load the last few hundred pounds, time is lost, and, invariably, materials are spilled on the ground and into the cockpit. Locate the hopper as close to the center of gravity as possible and anchor it securely to the main structure of the fuselage.

Shape.—Be sure the slopes of the hopper walls are steep enough to insure uninterrupted flow of the entire load to the outlet. Too little slope will cause some materials to lodge, resulting in erratic flow or materials remaining in the hopper. A slope of approximately 40° from horizontal is recommended. If a smooth material is used in hopper construction, the slope can be possibly 5° less.

Material.—Hoppers may be built of riveted or welded aluminum. Many are lined with fiber glass; others are built entirely of fiber glass. A desirable feature of fiberglass hoppers is that they are translucent and the hopper contents are usually visible to the pilot. This assists him in checking on the dispersal rate. Use a method of construction that will make the hopper liquidtight. This will provide a hopper that will not leak dust or liquid and permit the aircraft to be used for spraying by replacing the spreader with a pump, boom, and nozzles.

Filler

Make the loading door as large as practical to facilitate rapid loading and to reduce spillage. The door should fold forward, if possible, to permit loading from either side. Do not use sliding doors, because materials often get into the tracks, making them difficult to operate and sometimes preventing them from being closed tightly. This could be dangerous if the pilot is seated in an open cockpit behind the hopper.

Agitator

Equip the hopper with an agitator when sticky or lumpy materials are to be dispersed. A properly designed and functioning agitator assists in obtaining uniform flow of the hopper contents. Design the agitator so that it can be disengaged when free-flowing materials are to be applied.

Windmills on gearboxes are used to turn the agitators in almost all installations. A gearbox with a gear ratio of about 48 to 1 will handle a large variety of materials. A small wooden propeller is usually all that is needed to turn the gearbox. Do not use metal fans, unless they are especially designed or reinforced, because of the damage that can be caused if a blade should break off. Broken blades have been known to pass through the aircraft.

When materials that may pack in the hopper throat are to be dispersed, you may have to include a device that will stop the agitator when the gate is closed. You can do this by using a brake attached to the windmill and connecting the brake control to the hopper handle, so that closing the gate will also stop the agitator. You can also do this with a full-feathering windmill or a clutch to disengage the gearbox from the agitator.

Air Vent

Install an air vent in the hopper. This is particularly important if the hopper and loading door are liquidtight. Without a vent, flow rates are erratic and, at high application rates, there is danger of collapsing the hopper walls. Attach the vent at a high point in the hopper. Attach a tube to the vent and route it down through the bottom of the fuselage.

Gates and Gate Stop

The gate that controls the output of the materials should move freely, be warpproof and sturdy, and provide a tight seal when closed. Design it so that, when opened, the flow of materials to both sides will be uniform.

Make all linkage in the gate-control mechanism snug, so that, once adjusted, the open gate will always stop in the same place regardless of the number of times it is opened, whether it is slammed open, or opened slowly.

An adjustable gate handle stop is needed so that, once adjusted, the gate opening and calibration will remain the same. A long, fine-thread bolt to control the gate stop provides easy adjustment. A coarse-thread bolt or slotted short-leverage mechanism is not sensitive enough for precise adjustments. When the control gate is also used for emergency release of the load, the gate stop must be designed so that it can be flipped out of position to permit the gate to be opened wide.

Low-Rate Application Baffle

When it is necessary to apply material at very low rates, install a saw-toothed or slotted baffle or similar device directly above the control gate. This makes the gate movement less sensitive and simplifies calibration.

In designing such a baffle, arrange the openings so that materials will fall between all vanes of the spreader. Make all the openings somewhat smaller than may be necessary until after you have made swath checks. If the deposit pattern does not have the desired shape, you can raise low points in the pattern by increasing the size of the relative slot in the baffle. This way, you will not need to alter the vanes in the spreader and possibly alter the deposit patterns at higher application rates for which the spreader was designed.

Spreader

A spreader eliminates streaking, produces a pattern that will result in uniform treatment of an area, and produces a swath as wide as possible. Wide swaths reduce the amount of flying required to treat an area and provide somewhat more overlap, thus reducing the risk of skips when a pilot does not fly straight lines or when a flagman does not measure the spacing accurately.

The spreader in most common use is one suspended beneath the hopper and the fuselage where the airstream can pass through it. Hopper contents that fall through the gate opening are blown out at the rear of the spreader. Vanes within the spreader deflect the materials laterally. Lateral adjustment of the vanes permits adjustments of the deposit pattern.

While some spreaders are fan shaped, that is, wider at the outlet than at the inlet, some have a split or divided outlet, and some are shaped like an airfoil and positioned beneath the aircraft like an additional wing. A well-known example of the latter type is the Transland Swathmaster.

Trade names are used in this publication solely to provide specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture.

A centrifugal type of spreader is used on some helicopters. Materials are fed to a vaned horizontal rotating disk that flings the materials laterally to produce the swath. The disk is usually rotated by electric motor.

Other spreaders are being developed (1965). One is a spreader built inside a low-wing aircraft; the air velocity required to move the materials through it is provided by an engine-driven turbine. Another type is an endless belt housed in a long airfoil suspended beneath the aircraft. The airfoil is slotted and the materials are raked off the belt at each slot in quantities required to produce the desired deposit patterns.

PRECAUTIONS

An aircraft that is to be used as a duster must be sealed carefully to prevent dust from getting into the cockpit, fuselage, and wings. Place flexible boots over all push-pull tubes, cables, or moving mechanisms that extend through the structure at locations where dust may enter the aircraft. Some chemicals are dangerous if they are inhaled by the pilot, come in contact with his skin, or get on his goggles to obscure his vision. Some chemicals are highly corrosive to aircraft structure.

If the aircraft hopper is to be used as the spray tank too, seal all spray connections at the hopper to prevent the dry materials from entering and plugging them.

Because many chemicals are corrosive, thoroughly clean the hopper and interior of the aircraft frequently. This is especially important if the aircraft may be idle for a few weeks following a period of use.

When you load the aircraft with dry materials that may become lumpy or that may contain foreign materials that would not pass through the gate opening, use a screen to break up the lumps and clean the materials as they are loaded.

Mixing Equipment

Dusts and granules, baits, and fertilizers are usually ready for application when packaged by the formulating plants; however, many liquids for making sprays require mixing. Some sprays are made from wettable powders that are mixed with water; some have stickers added to them; some are concentrates that must be diluted with oil or water; and some may be combinations of two or more materials that are mixed together and diluted with oil or water.

Most liquid chemicals applied by aircraft can be mixed readily by circulation. A few require slow-turning paddles in the tank to assist in the mixing.

MIXING TANK

Use a cylindrical mixing tank—a cylinder has no corners in which wettable powders may lodge. The top should have an opening large enough so that powders can be emptied into the tank conveniently from 50-pound bags or drums. Cover the opening with a heavy screen to keep debris from falling into the tank; a screen re-

cessed below the opening or bordered by sideboards will facilitate fast dumping of the powder. The tank should have a capacity somewhat larger than the maximum amount that is planned to be mixed at one time. This will allow ample space for sloshing without the risk of overflowing the tank.

If you use circulation mixing, attach the return line at the bottom of the tank in such a way that circulation will cause the mixture to swirl. This will eliminate the foaming that results when the return flow is directed on top of the mixture. Also, the return flow washes the bottom of the tank to prevent some materials from settling out.

If a tank is mounted horizontally and there is a question of whether circulation is adequate, a tube with a series of holes drilled into it may be mounted horizontally a few inches above the bottom of the tank. Attach the tube so the flow from the holes is directed downward at an angle to the bottom.

MEASURING

Make provision to accurately measure the quantities mixed and loaded into each aircraft. Since meters cannot be used to measure some materials, because of their abrasiveness, use a calibrated measuring stick, calibrated sight gage, petcock, or other acceptable means of measurement.

If the mixing tank is mounted on a trailer or truck for convenient transport between worksites, provide support for the load when the tank is filled. Do this with jacks or blocks. When you move a fully loaded portable tank from one worksite to another, be sure to use a truck that is strong enough to support the load; be sure, also, that the top of the tank is sealed tightly to avoid sloshing through the filler or other opening.

CIRCULATION PUMP

If the mixing is to be done through circulation only, pumps should have adequate capacity to forcefully agitate the entire contents of the tank—materials will be mixed more rapidly and risk of applying poorly mixed chemicals will be reduced. A ¾-inch centrifugal pump is adequate for a 100-gallon tank. Increase pump size and capacity proportionately as the tank size is increased.

Through valves and additional plumbing, the circulation pump also may be used to fill the mixing tank with diluent and to load the aircraft. If you use the pump to draw water from ponds or streams, extreme care is necessary to insure that none of the mixture is allowed to flow back through the intake line and contaminate the water source.

MIXING PADDLES

If you use paddles for mixing, mount them to clear the bottom of the tank by only an inch or two. Mixing can begin when small amounts of liquid are put in the tank and can continue through filling and until the tank is almost emptied. The paddles should have a diameter no more than half the diameter of the tank. This is adequate to mix a full tank as well as

a partly filled tank, and small-diameter paddles make it easier to mix materials that foam when the paddles break the surface of the liquid.

In a paddle-type mixer, you must be able to vary the speed of the paddles. Some materials do not go into suspension as easily as others and may require fast agitation. Some materials need slow agitation. A mixture, once mixed, usually needs only slow agitation to keep it in suspension.

STRAINER

Install a large-capacity strainer with coarse screen in the loading line to catch any unmixed solids or foreign material.

SEALS

Use liquidtight packings to seal each shaft that passes through the wall of the tank.

OTHER EQUIPMENT

A mixing facility should have equipment to lift or handle full barrels or other large or heavy containers that must be emptied into the mixing tank. Added to the danger of injury to workers if they lift or move such containers is the possibility that dropped containers might burst and spill concentrates on workers or contaminate the mixing area. This could be extremely hazardous with concentrates of some chemicals.

Measuring cans, faucets, and racks are needed to measure the correct amount of technical or concentrate materials from barrel containers.

PRECAUTIONS

Wear clean protective clothing during all mixing operations. Use respirators appropriate to the chemical being mixed. Keep on hand an adequate supply of replacement filters. Clean water, soap, towels, eyewash and cup, first-aid kit, and salt and other antidotes should be available at all times during mixing operations.

Make sure all workers thoroughly understand the nature of the chemical being handled, the precautions to be observed, the antidotes, and the procedures to be followed in the event of spillage. Contact a doctor and a hospital in the area and explain the work being done so that they may become familiar with the treatment required in an emergency. Post the names of the doctor and hospital at the mixing site. When chemicals highly toxic to man are used, have at least two men present at all times to assist each other and, above all, to observe each other for symptoms of possible overexposure to the chemical.

When organophosphates are mixed frequently, all workers should take blood cholinesterase tests at regular intervals. To determine the normal cholinesterase level, have a test made before they handle the material.

Loading Equipment

Good loading equipment can add greatly to the efficiency of an aerial application operation. Of primary importance are rapid loading and

cleanliness of operations. Inspect loading equipment and service it frequently to keep it in first-class operating condition.

Provide workers who do the loading with appropriate clothing and devices that will protect them from exposure to the materials. Be sure they understand the precautions to be followed and be sure they know the antidotes to be used.

SPRAYS

Use a centrifugal pump for loading sprays, since it can pump a large variety of chemicals with minimum wear. Speed of loading will depend on the capacity of the pump. The speed of the pump should be controllable, so that materials that foam easily can be loaded at a slower rate. Placing the loading nozzle below the surface of the liquid or using a bottom-loading system will practically eliminate foaming when such materials are handled.

Use meters to measure solutions and other liquid mixtures that will not excessively wear the meter mechanisms. When loading abrasive sprays, use sight gages in the mixing tank and aircraft to determine how much is loaded.

Strainers in the loading system will remove foreign materials that may plug nozzles or the aircraft spray system. You should have several screen sizes, since all chemicals will not pass readily through fine-mesh screens. Use a screen size appropriate for the aircraft dispersal system.

The plumbing used to hook up a loading system should include as much tubing as is practical. Use chemical-resistant hose for the rest of the plumbing. The loading hose should be long enough to permit some leeway in parking the aircraft for loading. A short hose could easily result in lost time if careful maneuvering is necessary to get the aircraft into loading position. A long enough hose may allow avoiding possible collision with equipment while maneuvering into loading position.

Use quick-action, positive shutoff valves to start and stop the flow of materials being loaded. When specific quantities are to be loaded, such valves are particularly useful. If you use a quick-disconnect coupling, it should be leakproof and a type that will not release liquid each time it is disconnected.

DUSTS

Since only small aircraft are used for dusting, the dusts are usually loaded into the aircraft by hand. Dusts usually flow easily and seldom require screening during loading.

GRANULES, SEEDS, AND DRY FERTILIZERS

When quantities of these materials are to be dispersed, you can save considerable time by using a good mechanical loader. Mechanical loading usually provides a much cleaner operation than hand loading because more time can be devoted to emptying each bag or carton into the loader. Invariably, the rush during hand loading results in materials being left in the containers, being thrown over the

side of the aircraft—sometimes into the cockpit—or being blown overboard in the wind or the propeller blast.

Commonly used loaders are belt, chain, or auger types and gravity-flow hoppers that can be raised above the aircraft. Blower loaders are not recommended, because materials blown into hoppers may pack so tightly they will not flow when the gate is opened.

Belt loaders are fast and will handle a large variety of materials. When materials that contain oil cause the belt to become slippery, small cleats on the belt or daily washing of the belt will improve performance. Belt loaders will not break, grind, or shatter granules being loaded.

Chain or auger loaders will grind or break up some granules, such as those made of clay; however, they are satisfactory for loading other granulated materials. These loaders must be quite large, must have more powerful engines, and must be driven fast to approach the loading speed of the belt type. It is more difficult to lubricate chains and augers because the bearings are inside and exposed to the abrasiveness of materials being loaded.

Overhead hopper loaders are ideal if the aircraft load is limited to 1,200 pounds and the area above the loading door is not obstructed. This loader usually consists of a boom mounted on the front or rear of a ½-ton truck from which is suspended a hopper capable of holding one plane load, and that can be raised and lowered by cable and power takeoff or hydraulically. The hopper is lowered for convenient loading from the ground or from a truck, then raised as the loader is maneuvered up to the aircraft, and lowered until its snout enters the hopper loading door; then, the contents are released into the aircraft hopper in a few seconds. You can use hopper loaders for rapid loading of all dry materials. For some moist materials, a hopper made of rubberized cloth is ideal. Care and skill are required by the operator of a hopper loader to avoid damaging the aircraft during maneuvering and loading operations.

Screen all granulated materials before loading them into aircraft. This is necessary to break up any clods and remove debris. A two- to four-mesh screen is satisfactory for most materials.

APPLICATION

Pilot

The pilot is the key to efficient and successful aerial application. The importance of his training, ability, skill, judgment, and competence cannot be overemphasized. The aircraft must be operated in a proper and approved manner at all times.

The pilot must be able to determine the best direction to spray a

block and be adept at low-level navigation.

He must be trained in crop recognition, not only to insure that he is treating the right field but, more importantly, to insure that drift will not damage or leave an undesirable residue on crops or fields adjoining or downwind from the one being treated.

The pilot must be able to use good judgment in relating the amount of material applied to the size of the area treated.

He must be acquainted with each chemical he is applying; that is, he must know how to handle it safely, the clothing and devices that should be worn for protection, antidotes that will be required in the event of accidental overexposure, special precautions that must be observed when applying it, where it can be used safely, and the hazards if applied improperly or in the wrong places.

The pilot must know something about how weather affects the ap-

PRECAUTIONS

Wear shoulder harness and a good-quality, well-fitted crash helmet at all times during aerial application operations. These two safety items have saved more lives than all others.

Wear a respirator if the chemical being applied is dangerous. Use a filter or canister of a type appropriate for the chemical being used. Selecting the respirator carefully will pay dividends in its efficiency, usefulness, and wearing comfort. If one is needed for extended periods during hot weather, use a respirator-and-crash-helmet combination that is ventilated with forced air. If the equipment is uncomfortable, the pilot is tempted to work without it. This can be extremely dangerous. After use, clean this equipment and store it where it will not be damaged.

Wear clean clothing at all times. Many materials are highly toxic to man and can be absorbed through the skin. Stress personal cleanliness at all times.

When using rubber or rubberized gloves, keep the insides clean at all times. A mistake that is often made is removing the gloves to adjust or clean a nozzle or to do some other close work, then slipping the soiled hands back into the gloves. This can be extremely dangerous, because gloves may cause the hands to sweat; with the pores thus opened, the chemical is easily absorbed through the skin of the hands.

When you use organophosphates, you should take blood cholinesterase tests at regular intervals. To determine the normal cholinesterase level, take the initial test before handling the material.

During loading operations, get out of the aircraft and move to an upwind position to avoid fumes; be particularly careful when the chemicals used are toxic to man and the aircraft is being loaded from the top.

plication of sprays and dusts to crops. He must be able to anticipate when chemicals will drift and when they may not settle into the crops readily.

The pilot must be experienced with his aircraft, the maneuvers that can be performed safely and those that must be avoided, the maximum load it can carry safely, and the load limit from short, rough, temporary airstrips; above all, he must know his own limitations in the aircraft he is operating.

Application Methods

The normal procedure is to fly back and forth across the area being treated in straight, parallel lines. In areas too rugged or steep for the pilot to hold a uniform altitude and speed in both directions, the flight lines should follow the contours of the slopes. In mountainous terrain, where occasional areas are too hemmed in to permit contour flying, make all treatments downslope. Upslope treatments are extremely dangerous; never attempt them. Whenever possible, make the flight lines or swaths crosswind, to assist in overlap and uniformity of coverage, and lengthwise to the area, to reduce the number of turnarounds. Begin treatments on the downwind side of the area so that you can make each successive swath without flying through chemicals suspended in the air from previous swaths.

SWATH MARKING

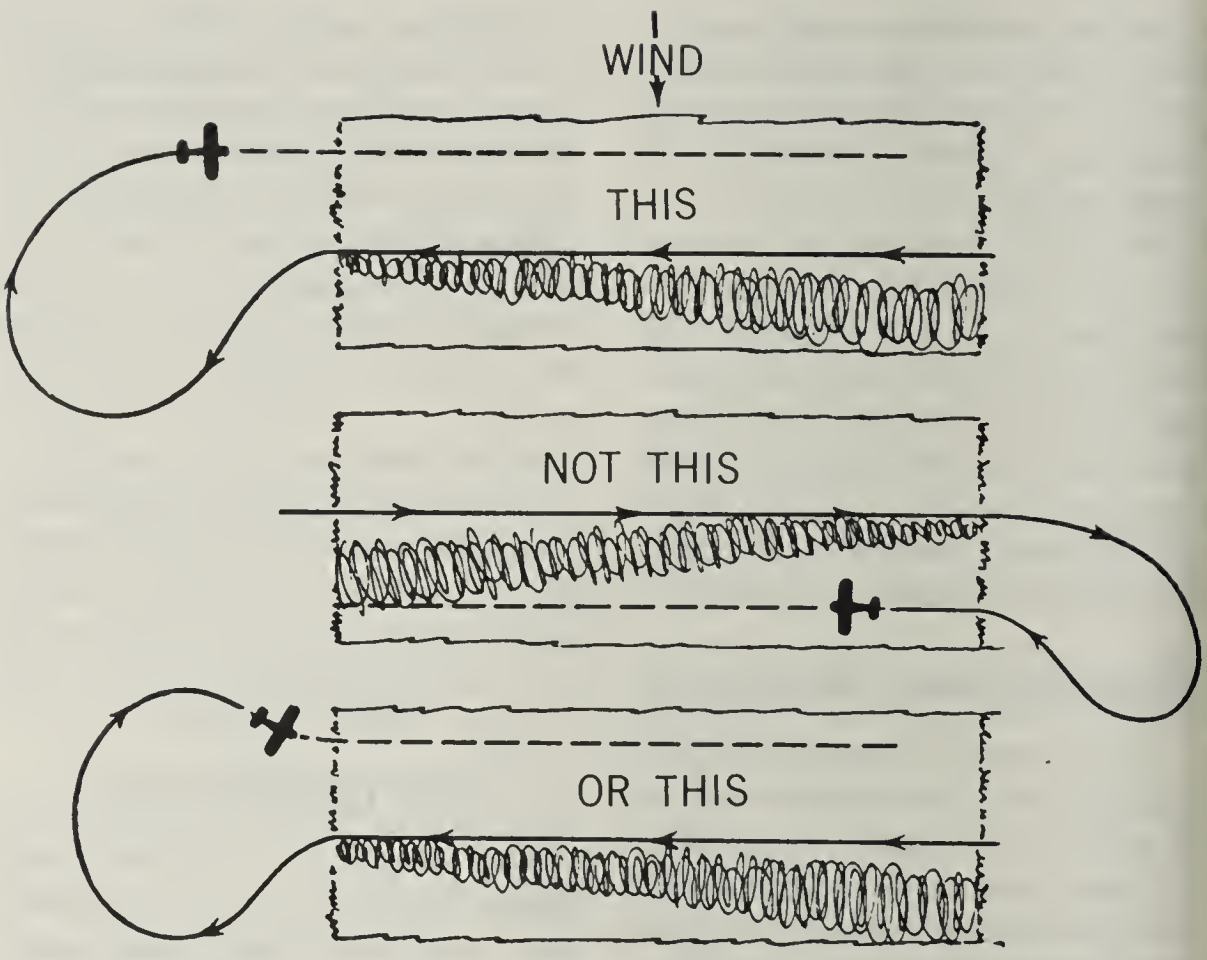
To insure uniform coverage and to avoid excessive overlap or stripping of the area, provide proper marking to guide the pilot on each swath. The most common method is to use a flagman at each end of the field. After each swath, the flagman moves over a distance equal to the predetermined swath spacing. The flagman determines this distance by pacing, using a measured line, or counting rows of row crops.

When the aircraft can be flown parallel to the rows of crops with straight rows, one flagman may suffice. When the area is more than 1 mile long, use enough flagmen so that the pilot can see at least one flag or marker at all times.

THE TURNAROUND

This maneuver is performed more often than any other during aerial applications and, when poorly executed, causes a large percentage of the accidents, many of them fatal. It requires careful execution, because the aircraft has often just climbed over an obstruction and immediately turned downwind at a considerable angle of bank. This puts the aircraft in a low-speed, high-drag angle of attack condition and the pilot usually is looking back to orient his turn for the next swath. Thus, the turn must be coordinated and performed smoothly.

Where possible, do not start the turnaround at the end of each swath until after pulling up over obstructions and leveling off; complete the turnaround before dropping in over the obstructions on the next swath. Start the turnaround by turning 45° downwind, leveling off for several seconds, then making a smooth coordinated reversal of 225°. The



Flight path during turnaround.

number of seconds you spend in level flight is determined by the swath spacing or distance the aircraft must move over, maneuverability of the aircraft, power, load remaining, wind, temperature, elevation, and other factors that may reduce the safe turning speed. As you continue the last of the turn, orient yourself in time to line up for the next swath. It is during this part of the turn that pilots often encounter difficulty, and you need careful timing to avoid fast or intricate maneuvering to get into position.

Avoid snapped reversal, lowball, or wingover turns at all times.

When you must make a turn in the opposite direction—that is, upwind first—you need more space and time to complete the turn.

Whenever possible, avoid turnarounds over a residence, farm buildings, penned poultry or livestock, watering places, ponds, and reservoirs. Be particularly careful if the dispersal apparatus shutoff is not always positive.

FERRYING

Fly at least 500 feet high during ferry flights between the airstrip and worksite, whether loaded or empty. Avoid flight over farm buildings, scattered residential areas, and penned poultry or livestock. Too often, because of the noise they make or their mere presence, agricultural aircraft are ac-

cused of damaging or contaminating property.

SPEED

Control of speed during aerial application is important. Calibration of dispersal apparatus is actually rate of flow per minute. No device is available that changes flow rate automatically and proportionately as the speed of flight changes. Once the dispersal apparatus has been properly calibrated, keep the speed constant during each swath run to insure uniform coverage of the area. Increasing the speed will result in too light a deposit. Decreasing the speed will result in overdosing.

HEIGHT

The height of flight usually is determined by the form of chemical material. Sometimes the type of material determines the height of flight; weedkillers are an example—drift of these chemicals cannot be tolerated. Arrange nozzles and adjust distributors to produce the desired deposit pattern with the material being applied from the flight level you select. Keep this height constant during each swatch run to obtain uniform coverage of the treated area.

Seeds usually are applied from wingspan height.

Whenever you can increase the flight level up to a height equal to the wingspan without increasing the drift hazard or sacrificing penetration benefits, you should do it. The added height usually increases the swath width and safety of operations. There is less danger of striking objects hidden near the crop level. The pullup over obstructions is not as high, steep, or abrupt; this greatly reduces the risk of stalling or misjudging the nearness or height of the obstruction. Likewise, reentry to the field is not as steep, abrupt, or low; the risks of stalling when you go in as close to the obstruction as possible after crossing over it and of misjudging the drop to the crop level are reduced, too. In the event of an engine malfunction, the added height provides some leeway to maneuver and possibly effect a safe landing.

APPLICATION AROUND OBSTRUCTIONS

When there are powerlines or telephone lines within or on the end of the area being treated, common practice is to fly under them if the application height is lower than 10 feet and there are no additional obstructions between the lines and the ground. When you fly around them, exercise extreme caution; make certain there are no diagonal brace wires or other lines that may be difficult to see.

When you must pull the aircraft up over an obstruction at the end of the field, shut off the dispersal apparatus before the pullup is started. This may be one or two swath widths from the end of the field. After the turnaround, drop the aircraft in over the obstruction to the proper application height, and turn on the dispersal apparatus at a point even with the point where the other swath was shut off. After you run all the parallel

swaths, finish treating the field by flying one or two swaths, as needed, across the end of the field and parallel to the obstruction.

When there is an obstruction along the side of the field, fly the aircraft parallel to the obstruction, as close to it as is safely possible, at a height appropriate for the material being applied.

When there is an obstruction, such as an occasional tree or pole, within a field, and the height of flight is 10 feet or less, approach the obstruction in the same manner as one at the end of the field—that is, shut off one or two swath widths from the obstruction. After making the pullup, make a 360° turn before dropping in on the other side. This is necessary to control the speed sufficiently to avoid overshooting the other side. After working past the obstruction, you can run one or two swaths on both sides to complete the treatment around the obstruction.

Treating the areas around the obstructions in this manner will prevent skips or overdosing.

DRIFT

Drift is the movement of released material from a path of vertical descent caused by air movement.

You cannot completely eliminate drift when you apply dusts or sprays by aircraft. You can, however, reduce the quantity and extent of drift.

The necessity for controlling drift depends on the circumstances prevailing at the time and place of application. Special precautions will be needed if the material being applied is hazardous to adjacent or nearby areas—susceptible crops, crops for which a residue tolerance is in effect, reservoirs, streams, human beings, livestock, pastures, and buildings.

The main factors that influence the distance the material will drift are particle size, specific gravity, evaporation rate, height of release, horizontal air movement, vertical air movement, temperature, humidity, and aerodynamic forces created by the aircraft.

The rate of fall of particles through the air is affected by their size and specific gravity. Small, lightweight particles fall very slowly. For example, a 5-micron (1 micron=0.001 millimeter or 25 microns=0.001 inch) drop of water would require 5½ hours to fall 50 feet in still air as compared to only 55 seconds for a 100-micron drop under the same conditions (disregarding evaporation).

The average particle size of dusts is considerably smaller than that of sprays. Dusts, therefore, tend to drift farther than sprays. If there is a choice between dusts or sprays, always use sprays to reduce drift hazards. This will not always be possible, since there are situations where dusts may provide more effective plant coverage than sprays for control of certain plant diseases. Also, some sprays may be phytotoxic (poisonous to plants).

Oil-spray droplets tend to drift farther than water-spray droplets because they usually are lighter and thus remain airborne for a longer period. The rate of evaporation of water-base sprays is higher than

that of oil-base sprays unless anti-evaporant materials are added to the formulation.

With present commercial spray equipment and spray formulations now available (1965), all small particles cannot be eliminated. A coarse spray has a wider range of sizes (a higher maximum) than a fine spray. Although a coarse spray will drift less than a fine spray, the coarse spray results in narrower swaths with fewer drops per unit of area. When the average drop size is doubled, the number of drops in a gallon will be reduced to one-eighth the original number.

If thorough coverage is required for control of a specific pest, coarse sprays may not be economical or effective. For some herbicides, however, coverage may not be critical, and moderately coarse sprays can be effective. To reduce drift, the atomization should be no finer than is necessary to do an effective job.

The main factors affecting the distance a particle may drift while it is falling are height of release and horizontal and vertical air movement. For example, a 50-micron droplet of water will drift about 890 feet while falling 50 feet in a 3-mile-per-hour wind. Doubling either the height or the windspeed should double the distance.

Height of flight of the plane above the crop should not be greater than that required for effective lateral distribution of the material across the swath and safety of operation. This may vary from a few feet over low-growing crops to 100 feet or more over mountainous forest areas. Reducing the height of flight will reduce the drift.

Weather conditions directly affect the direction, amount, and distance of drift. Except under calm conditions, you can readily determine the wind direction in the field. Avoid applications when the wind is blowing toward susceptible crops. You may have to cease operations until conditions change. You can make windspeed readings in the field with small pith-ball windmeters. Consult weather forecasts whenever possible. One danger from drift is that unpredictable changes in air movement may occur to move the drift in an unexpected direction.

During early-morning and late-evening hours, the air temperature differential between ground and 10 to 20 feet above ground is considerably less than during the middle of the day. As the ground warms up, ground air temperatures increase above that of the air at 10 to 20 feet. This warmer air rises and sets up convection and thermal air currents to lift small particles, which may be carried to some distant point before they settle out. Avoid application when this condition exists.

Calm conditions with a high inversion (ground air 2° to 5° cooler than air above) may cause the smallest spray drops or dust particles to remain suspended in this layer of cold undisturbed air and eventually move out of the area before coming to rest. Avoid application under this condition.

Because of the aerodynamic forces set up by the aircraft moving

through the air, spray or dust released within 3 to 5 feet of the wingtips of fixed-wing aircraft may be moved outward and upward by the wingtip vortices and be moved out of the treated area by the wind.

On spray planes, limit the boom length to three-fourths of the wingspan so that spray will not be emitted near the wingtips. Use leakproof on-off spray valve and dusttight hopper feed gate to eliminate dribbling in turns or ferry flights.

Deposit Pattern and Swath Spacing

Test dispersal apparatus to determine the swath spacing and whether adjustments are necessary to produce the desired deposit patterns. The widths of swaths vary with different materials, the altitudes from which they are released, and the dispersal apparatus. Use materials for swath checking that are as similar as possible to those that will be used on the job. For example, lime can be used in lieu of insecticidal dust, dyed water or oil in lieu of some sprays, and inert clay granules in lieu of treated granules. Make the final check with the material that will be used.

You can check deposit patterns in several ways. A common practice is to use dyed water for water-mixed sprays and catch the spray on clean 4- by 5-inch cards or long strips of adding machine paper. The droplets will spread less on a hard-finish paper and you will ge some indication of the droplet siz

The same procedure can be fol lowed when running swath check with oil or you can use oil-sensitiv dyed cards. With these, the oil i not dyed and the droplets wash small spots on the cards.

You can use pans or trays t catch granules.

DUST

Since almost all dusting is don with the aircraft wheels at cro level, the swath spacing used is usu ally eqnal to the wingspan of th aircraft. Sometimes, you can in crease this somewhat through th use of a special spreader. Quit often, when treating row crops, th spacing is adjusted to coincide with a given number of rows. This enables a flagman to count rows fo his spacing rather than to measur or pace the distance.

Swath checks are seldom made with dust other than to assure there is no streaking. If streaking occurs, make adjustments to the spreader or distributor rather than increase the height of flight. Increasing height increases the drift hazard.

When conditions are such that you cannot apply dust from crop level because of obstructions in and around the field being dusted, consider using another form of chemical.

SPRAYS AND GRANULES

The normal procedure for determining the deposit pattern and

swath spacing with sprays and granules is as follows: Place a number of cards or pans in a straight line perpendicular to the line of flight, adjust the dispersal apparatus to put out the estimated rate required, and fly the aircraft over the cards or pans at its assigned height and speed. After crossing them, maintain a straight and level course for approximately one-half mile to avoid distorting the deposit pattern.

Sprays

Water-mixed sprays on croplands usually are applied from low levels to reduce evaporation. Swath spacing seldom is much wider than the wingspan of the aircraft. In a no-wind condition, swath width usually increases with altitude until you reach a height approximately equal to the wingspan. Little is gained by flying much higher, and the spray becomes more difficult to deposit on the intended area.

Water-mixed sprays on forest and range lands usually are applied from wingspan height, and the swath spacing that can be used for this height usually is equivalent to three to four times the wingspan.

Usually, you apply an insecticidal oil spray from wingspan height with swath spacing equivalent to four times the wingspan. Apply herbicide at lower altitudes and narrower swath spacing.

When you disperse invert emulsions, run swath checks in advance to determine the spacing, since so much depends on the type of dispersal apparatus used.

Granules

Because of the wide variation in granule sizes and types used, run swath checks with each type to determine the deposit pattern and swath spacing to be used. Granules usually are applied from wingspan height to get as wide a swath as possible.

When you make swath checks with granules, the best method is to use containers or trays of equal surface area placed at 5-foot intervals across the line of flight. Aluminum dishpans or similar containers usually are used for this. Visual checking of the deposit in each pan can be deceiving; so you should check the pattern more accurately.

One method you can use is to obtain a precision-bore glass tube (¼-inch inside diameter) closed at one end. Pour the contents of the first pan into the tube. While holding the tube vertically, place a sheet of paper behind the tube and make a mark on it equal to the height of the contents in the tube. After emptying the tube, pour the contents of the second pan into the tube and mark the height on the paper. Make the second mark 1/4 to 3/8 inch away from the first mark. Follow this procedure with each consecutive pan. Connecting the marks with a line will graphically show the deposit pattern.

You can make a more elaborate device with a case containing about 20 of these tubes, set side by side with a small space between. If you pour the contents of each pan into each respective tube, you will get a picture of the deposit pattern.

Case with glass tubes to show granule deposit pattern.

The span of receptacles that catches materials is considered the overall swath. Use careful judgment in considering the number of receptacles that should be included in the swatch. Do not include receptacles that do not contain at least a reasonable deposit commensurate with the application rate, desired pattern, type of material, purpose of the treatment, and other factors.

Do not confuse overall swath with effective swath. Generally, overall swath is the total span of materials deposited in one swath; effective swath is the span of materials where there is sufficient deposit to obtain the desired results. The effective swath may be less than one-half of the overall swath.

Conduct tests to determine the effective swath and spacing to be used during calm or as near to calm conditions as you can find. If there is any measurable wind, fly the aircraft directly into the wind during the tests so that the drift does not widen the swath.

DEPOSIT PATTERNS

Carefully consider the deposit pattern that you select for use. Obviously, you should not use a rectangular deposit pattern, for it is impossible to fly the aircraft so straight that there would be no skip or overlap. The pattern should have sloping sides.

When you use a trapezoidal pattern, deposit will be uniform if the aircraft is spaced properly and evenly. Deposit will be less distorted when you have uneven spac-

ng than with the rectangular pat-
ern.

You can obtain the ultimate in leposit uniformity by using a pat-ern shaped like an isosceles tri-ngle and by spacing the aircraft t one-half of the overall swath. This pattern is the most desirable vhen you apply granules as soil reatments and desire perfect uni-ormity. When you use this pat-ern, deposit will be least distorted y uneven flight lines or spacing, ight shifting winds, gusts, or other actors.

Once you select the deposit pat-ern, it is important to space the air-raft the correct distance on each uccessive swath to obtain uniform overage of the area being treated. Stretching a swath beyond the oint where adequate overlap or niform coverage is obtained is alse economy. When you do this, ght deposits occur where there is nsufficient overlap and the risk of skips increases. If you apply sufficient material to provide an adequate deposit in the light overlap area, you apply too much material in the center. This is wasteful and results in overdosing.

CALIBRATION

After you achieve the desired deposit pattern and determine the swath spacing, you must calibrate the dispersal apparatus accurately so that you apply the correct amount of material per acre.

Calibration is a function of swath spacing, speed (time) or measured distance, and application rate per acre. You can calibrate equipment by timing the flow rate of a measured quantity or checking the number of swaths that can be made with a measured quantity in a field of known length.

You can calculate calibration requirements by referring to the following charts:

Computation of Acreage and Materials

$$\textit{FORMULA: Acres covered} = \frac{\textit{Length of swath in miles} \times \textit{width of swath in feet}}{8.25}$$

The number of acres in a swath of given width and length can be determined from the chart below.

xample: **An aircraft with a 40-foot effective swath treats a strip 1 mile long. To find the number of acres llow the 40-foot vertical column down until it intersects the 1-mile line. The answer to the nearest tenth is acres. For swath widths other than those shown, interpolate or use combinations of the figures shown. To determine the amount of chemical required, multiply the acres by the desired rate of application.**

ACREAGE CHART

Swath length (miles)	30′ swath	35′ swath	40′ swath	45′ swath	50′ swath	75′ swath	100′ swath	200′ swath	300′ swath	500′ swath
	.9	1.1	1.2	1.4	1.5	2.3	3.0	6.1	9.1	15.2
	1.8	2.1	2.4	2.7	3.0	4.5	6.1	12.1	18.2	30.3
	2.7	3.2	3.6	4.1	4.6	6.8	9.1	18.2	27.3	45.4
	3.6	4.2	4.8	5.5	6.1	9.1	12.1	24.2	36.4	60.6
	7.2	8.4	9.8	10.9	12.1	18.2	24.2	48.5	72.7	121.2
	10.8	12.6	14.5	16.4	18.2	27.3	36.4	72.7	109.1	181.8
	14.4	16.8	19.4	21.8	24.2	36.4	48.5	97.0	145.4	242.4
	18.0	21.0	24.2	27.3	30.3	45.5	60.6	121.1	181.8	303.0

Aircraft Calibration

$$\textit{FORMULA: Acres per minute} = \frac{2 \times \textit{swath width} \times \textit{miles per hour}}{1{,}000}$$

The chart below shows the rate, in acres per minute, at which spray of dry material can be applied when swa width and speed of aircraft are known. For swath widths or aircraft speeds other than those shown, interpola or use combinations of the figures shown. To find the rate of flow in gallons per minute or pounds per minut multiply the acres per minute figure by the number of gallons or pounds per acre to be applied.

Example: A 100 mile per hour aircraft has a 40-foot effective swath. Follow the vertical 40-foot column dow until the figure opposite 100 miles per hour is intersected. The aircraft would cover 8.0 acres per minute. If gallon of spray is to be applied per acre, the aircraft should be calibrated to disperse liquid at the rate of 1 8.0 or 8.0 gallons per minute. If 10 pounds of dry material is to be applied per acre, the aircraft should be cal brated to disperse material at the rate of 10 x 8.0 or 80 pounds per minute.

ACRES-PER-MINUTE CHART

Speed (m.p.h.)	30′ swath	35′ swath	40′ swath	45′ swath	50′ swath	75′ swath	100′ swath	200′ swath	300′ swath	500′ swat
75	4.5	5.2	6.0	6.7	7.5	11.2	15.0	30.0	45.0	75.
80	4.8	5.6	6.4	7.2	8.0	12.0	16.0	32.0	48.0	80.
85	5.1	5.9	6.8	7.6	8.5	12.7	17.0	34.0	51.0	85.
90	5.4	6.3	7.2	8.1	9.0	13.5	18.0	36.0	54.0	90.
95	5.7	6.6	7.6	8.5	9.5	14.2	19.0	38.0	57.0	95.
100	6.0	7.0	8.0	9.0	10.0	15.0	20.0	40.0	60.0	100.
110	6.6	7.7	8.8	9.9	11.0	16.5	22.0	44.0	66.0	110.
120	7.2	8.4	9.6	10.8	12.0	18.0	24.0	48.0	72.0	120.
130	7.8	9.1	10.4	11.7	13.0	19.5	26.0	52.0	78.0	130.
140	8.4	9.8	11.2	12.6	14.0	21.0	28.0	56.0	84.0	140.
150	9.0	10.5	12.0	13.5	15.0	22.5	30.0	60.0	90.0	150.

PROTECTION AND STORAGE OF CHEMICALS

Keep chemicals and chemical containers in a separate building or room or in an enclosure. Use this storage area exclusively for chemicals and empty chemical containers. Buildings or rooms should be dry, ventilated, and under lock and key. Fence in outside storage areas to protect children and animals and to discourage pilferage.

Remove only the amount of chemicals needed for 1 day's operation, and be sure to return empty containers (and any unused chemical) to the storage area at the end of each day.

PRECAUTIONS

Do not store herbicides or defoliants in the same room with insecticides. Volatile materials such as 2,4–D and its derivatives can contaminate other chemicals. Chlorate salts can create a fire or explosion hazard.

SAFE DISPOSAL OF CONTAINERS AND CHEMICALS

Careful disposal of empty chemical containers and surplus chemicals is as important as using the chemicals safely. You can harm yourself and others and contaminate the area around you if you do not follow safe disposal procedures.

"Empty" containers can be a hazard to children and pets. Barrels and drums converted into livestock

eed troughs, water storage tanks, r raft floats become sources of con- amination of feed and water. If liscarded in the line of water run- ff, these containers can pollute onds and streams.

Your responsibility as a chemical ser continues until you safely dis- ose of chemical containers and any urplus chemicals.

Empty Containers

Your choice of disposal methods nd necessary precautions will de- end on the type of container and acilities available. Regardless of he disposal plan you follow, how- ver, you can lessen the amount of azard by—

- Draining any chemical remain- ng in the container into a pit dug n sandy soil isolated from water ources.
- Rinsing glass and smaller metal ontainers several times with the liluent being used and including he rinse in your spray.
- Keeping lids and bungs tightened t all times when containers are not eing used.
- Keeping all empty containers in secure storage area until they can e disposed of safely.

Large metal drums can be dis- osed of most safely and easily by eturning them to the supplier or elling them to a cooperage firm quipped to handle toxic materials. hemical containers also can be afely disposed of locally at public umps, incinerators, or private dis- osal sites.

PUBLIC DUMP OR INCINERATOR

If disposal is at a dump or incinerator, notify the operator of the nature of the material so that he can take any necessary precautions. Before leaving the disposal site, remove lids and bungs, break glass containers and chop holes in the top, bottom, and sides of metal containers with a sharpened pickax. Breaking and puncturing containers will make it less likely that an unauthorized person will remove them from the dump and attempt to convert them to other uses. Bury containers left at public dumps.

PRIVATE DISPOSAL SITES

If suitable public disposal facilities are not available and containers cannot be returned to a supplier or sold to a cooperage firm, select a disposal site that will be used only for surplus chemical and chemical containers. Do not use an area that might later be returned to cropland. The site should be away from homes, wells, streams, and crops and livestock. Level ground is best because residue will be absorbed through the soil and will be less likely to be carried away in water runoff. Do not locate the site on the watershed of a public water supply or where livestock have access to it.

BURNING

Burn paper bags, cardboard boxes, and plastic containers after you make sure that smoke will not drift

over nearby homes, people, and livestock. Be particularly careful that you do not stand in the smoke. If you pour used crankcase oil over the containers before lighting, they will burn easily. (CAUTION: Some municipalities have restrictions against burning. Consult local authorities before burning containers. Do not burn containers that have held herbicides, such as 2,4-D and its derivatives. When these herbicides volatilize, the resulting vapor may damage nearby plants, crops, and shrubbery. Also, herbicides or defoliants containing chlorates may explode when heated.)

You can decontaminate metal and glass containers by burning. After removing lids, use a sharpened pickax to chop holes in the top, bottom, and sides of metal containers. Build a heap of scrap wood, dry brush, or anything else that will make a hot fire. Then place containers on the pile and start the fire.

Heat containers until they are red hot and hold them at that temperature (800° to 1,200° F.) for at least 5 minutes.

You can construct your own incinerator for burning small containers from a 55-gallon drum. Remove one end from the drum and punch holes in the sides, leaving room at the bottom of the drum to hold the fuel. Fuel oil or used crankcase oil will provide complete combustion, yet is safe to use if handled carefully.

CLEANING

If burning is not possible, a thorough rinsing procedure will eliminate much of the pesticide residue and hazard. Here is the recommended rinsing procedure:

Carefully rinse empty container with water and detergent. Allow water and detergent to remain in the container for 15 minutes with intermittent agitation. Pour rinse solution into a pit dug in sandy soil. The following shows rinsing solutions for containers of three sizes:

Container size (gallons)	*Water (quarts)*	*Detergent*
5	2	2 tablespoons
30	12	½ cup.
55	20	1 cup.

Rerinse container for another 1 minutes with the same amount o water and detergent. Again pou rinse solution into the pit. Inver container and let it drain for 1 minutes into the pit.

Flush drum thoroughly wit clean water. (CAUTION: Althoug they may appear to be completel free of residue, do not use these con tainers for storing human or anima food or water.)

HERBICIDE CONTAINERS

Break glass containers and cho holes in the top, bottom, and side of metal containers so they canno be reused or collect water. A sharpened pickax is best for thi purpose.

Bury all broken or puncture containers to a depth of 18 inche at a safe disposal site or take them to a dump where they will be cov ered with soil.

RETURN TO SUPPLIER OR SALE TO COOPERAGE FIRM

If you plan to turn containers over to the supplier or cooperage firm, tighten the bungs, rinse the drums off with water, and keep them in the storage area until they are picked up. Many of these drums rust rapidly and lose their value after more than one season; make sure they are collected by the cooperage firm as soon as possible. You can obtain the names and locations of established cooperage firms from your chemical dealer or formulator.

Surplus Chemicals

Keep surplus chemicals in the original containers in the storage area until they can be disposed of safely. If you cannot give surplus chemicals to a responsible person in need of such material, pour them into a hole dug in the ground and cover with dirt to a depth of at least 18 inches. Observe all precautions recommended for private disposal sites. Do not take surplus chemicals to a public dump or incinerator. Pour leftover spray mixture into a pit dug in sandy soil.

REGULATIONS

Two distinct types of regulations pertain to pesticides. Some regulations pertain to the labeling and marketing of pesticide products; others pertain to the users of pesticides. Labeling and marketing controls of such products operate at both the Federal and State levels. Pesticide-use regulations, however, are administered only at the State or local level, and no Federal controls govern the user or applicator.

Pesticide Products

Few, if any, products are more closely regulated than those intended for use as pesticides. The Federal Insecticide, Fungicide, and Rodenticide Act, which is administered by the U.S. Department of Agriculture, regulates those products sold in interstate commerce, while State laws regulate the same products at the local level and also regulate pesticide products that are manufactured and sold within the same State.

FEDERAL REGULATIONS

The following is a brief summary of the Federal law and its requirements:

Title

Federal Insecticide, Fungicide, and Rodenticide Act, as amended.

Enforcement Agency

Pesticides Regulation Division, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C., 20250.

Coverage

Algaecides, germicides, fungicides, herbicides, insecticides, nema-

tocides, plant defoliants, plant desiccants, plant regulators, rodenticides, amphibian and reptile poisons or repellants, bird poisons or repellants, fish poisons or repellants, mammal poisons or repellants, and invertebrate animal poisons or repellants that are marketed or shipped in interstate commerce, imported, exported, or sold in the District of Columbia or any of the territories.

Duration of Registration

Registration is effective for 5 years from date of registration, at which time it is canceled or extended for an additional 5 years.

Registration Information

1. To comply with the act, a label must show—

- Name of product.
- Name and address of manufacturer, registrant, or person for whom manufactured.
- Net contents.
- Ingredient statement (name and percentage, by weight, of each active ingredient, and total percent of inert ingredients or name of each active and each inert ingredient in descending order and relative abundance in each category and the total percentage of inert ingredients).
- Warning or caution statement.

a. An economic poison must show warnings pertaining to ingestion, skin absorption, inhalation, and flammability or explosion.

b. Economic poisons that are highly toxic to man must show "POISON" in red on a contrasting background, "DANGER," skull and crossbones, and statement of antidote, including directions to call physician immediately (in immed ate vicinity of skull and crossbon and "POISON").

- The registration number assigne to the product.
- Directions for use (optional c label, may appear on accompanyir printed or graphic matter).

2. Other information that may l required is—

- Data to support any or all clain on the labeling.
- A complete statement of the con position of the product, includin the percentage, by weight, of eac of the active and inert ingredient if such information does not appe on the label.
- Any pertinent information abou inert ingredients.
- Any other information pertainin to physical or biological propertie of the product.

Coloration

Standard and basic lead arsenat calcium arsenate, magnesium arse nate, zinc arsenate, zinc arsenit barium fluosilicate, sodium fluorid and sodium fluosilicate shall be col ored or discolored. The hues, va ues, and chromes specified are thos contained in the Munsell book o color, Munsell Color Co., Baltimor Md.

Obtaining Registration

A manufacturer must submi copies of his labeling and adequat research data to support all th claims made for the product. Th labeling and supporting data ar carefully reviewed by specialists t determine the following:

1. Will the product be effective ainst the pests named on the la- lling, and can it be used effectively thout causing damage to the ops or objects to which it is plied?

2. Does the label bear warning d caution statements that are ade- ate, when complied with, to pre- nt injury to the user or other per- ns or beneficial animals that are posed?

3. Will the directed use of the oduct leave illegal residues on rvested food or feed?

If the specialists involved are nvinced that the product can be ed effectively and safely without aving illegal residues on food or ed when label warnings and di- ctions are carefully followed, it acceptable for registration.

STATE REGULATIONS

Forty-eight States have laws that gulate the marketing of pesticides ithin the respective States. All ese State laws require that the oducts subject to their provisions ust be registered with the control- ng State agency in the same man- r as described for the Federal w. The scope of products covered the various State laws is shown table 1.

Most of the control officials are embers of and take an active part the functions of the Association American Pesticide Control Of- cials. This association attempts to tablish uniform requirements and avoid conflicts between the vari- s State laws and the Federal law. model State law has served as a ttern for those States changing or adopting a pesticide law; in summary, this law parallels the summary of the Federal law, with minor changes adapting it to the State level. These changes are indicated in table 1.

Residue Tolerances

The Federal Food, Drug, and Cosmetic Act authorizes the Food and Drug Administration of the U.S. Department of Health, Education, and Welfare to set tolerances for residues of pesticides that may legally remain in or on food or feed. That agency has set up the following procedure for establishing tolerance.

1. When a manufacturer applies to the U.S. Department of Agriculture for registration of a product under the Federal Insecticide, Fungicide, and Rodenticide Act with directions for use on a food crop in a manner that will leave residues on the harvested food, he is told that registration will not be issued until a tolerance is established to cover the residues.

2. The manufacturer must then assemble and submit to the Food and Drug Administration residue data to show conclusively the level of residues likely to result and toxicity data to prove that such residues on the food would be safe.

3. The U.S. Department of Agriculture must certify to the Food and Drug Administration that the pesticide is useful for the proposed use and express an opinion on the adequacy of the residue data. Specialists in the Food and Drug Administration then carefully evaluate the

TABLE 1.—*Summary of Pesticide (Economic Poisons) Laws*

State	Products covered						Registratio required
	Insecticides	Fungicides	Rodenticides	Herbicides	Defoliants and desiccants	Plant regulators	
Alabama	X	X	X	X			X
Alaska							
Arizona	X	X	X	X	X		X
Arkansas	X	X	X	X			X
California	X	X	X	X	X		X
Colorado	X	X	X	X	X	X	X
Connecticut	X	X	X	X	X	X	X
Delaware							
District of Columbia[1]	X	X	X	X	X	X	X
Florida	X	X	X	X		X	X
Georgia	X	X	X	X	X	X	X
Hawaii	X	X	X	X			X
Idaho	X	X	X	X	X	X	X
Illinois	X	X	X	X	X	X	X
Indiana				X			X
Iowa	X	X	X	X	X	X	X
Kansas	X	X	X	X	X	X	X
Kentucky	X	X	X	X			X
Louisiana	X	X	X	X	X	X	X
Maine	X	X	X	X	X	X	X
Maryland	X	X	X	X			X
Massachusetts	X	X	X	X	X	X	X
Michigan	X	X	X	X	X	X	X
Minnesota	X	X	X	X			X
Mississippi	X	X	X	X			X
Missouri	X	X	X	X			X
Montana	X	X	X	X			X
Nebraska	X	X	X	X	X	X	X
Nevada	X	X	X	X			X
New Hampshire	X	X	X	X			X
New Jersey	X	X	X	X	X	X	X
New Mexico	X	X	X	X	X	X	X
New York	X	X	X	X	X	X	X
North Carolina	X	X	X	X			X
NorthDakota	X	X	X	X			X
Ohio	X						X
Oklahoma	X	X	X	X	X	X	X
Oregon	X	X	X	X	X	X	X
Pennsylvania	X	X	X	X	X	X	X
Rhode Island	X	X	X	X			X
South Carolina	X	X	X	X	X	X	X
South Dakota	X	X	X	X			X
Tennessee	X	X	X	X	X	X	X
Texas	X	X	X	X	X	X	X
Utah	X	X	X	X	X	X	X
Vermont	X	X	X	X	X	X	X
Virginia	X	X	X	X	X	X	X
Washington	X	X	X	X	X	X	X
West Virginia	X	X	X	X	X	X	X
Wisconsin	X	X	X	X		X	X
Wyoming	X	X	X	X			X
Puerto Rico	X	X	X	X	X		X

[1] Federal Insecticide, Fungicide, and Rodenticide Act applies.

ta to determine whether a toler-
ce is justified.

4. If the residue and toxicity data e found to be adequate, the toler-ce is established and the Depart-ent of Agriculture can issue regis-ation. If the data are determined be not adequate to justify the pro-sed tolerance, the Food and Drug dministration will refuse to estab-h the proposed tolerance and may tablish a tolerance at a lower level a zero tolerance if the data war-nt such action. In no case will the ood and Drug Administration es-blish a tolerance greater than is eded to cover the residue result-g from the proposed use.

5. When a pesticide is registered r use on a food crop on the basis a zero tolerance or on a no-sidue basis, it means that the rected use will not leave residues the harvested food at levels that n be detected by chemical ana-sis. This has often meant that the development of a more sensitive method invalidates the zero tolerance or no-residue acceptance.

Application Laws

Federal Aviation Agency regulations control all aerial operations; in addition, some State laws must be observed when pesticides are applied.

Many of the States have pesticide-use laws that require custom applicators to be licensed or to obtain a permit from the State prior to the application of such products. Table 2 lists those States that have such laws, and the extent of coverage. As shown, the requirements of various State laws vary widely. You are responsible for determining which laws apply to your operations in a particular State or locality. You should learn the requirements of such laws in order to comply with them.

CHEMICALS

Agricultural chemicals vary idely in toxicity, chemical prop-ties, and biological activities. urrently (1965), more than 600 tive chemical ingredients are em-loyed in the control of pests. hese range from certain plant de-vatives that are relatively low in oxicity to many extremely toxic ompounds.

Classes

BOTANICALS

General description and use.—A umber of chemical compounds are derived from plant tissues and used rather effectively as insecticides and rodenticides. More common plant derivatives that might be applied by aerial applicators include pyrethrins, rotenone (derris), nicotine, sabadilla, ryania, and possibly strychnine. The last named is a rodenticide; the others are insecticides.

Relative toxicity and mode of action.—The toxicity of plant derivatives used as pesticides varies from pyrethrins, which have a very low degree of toxicity to warm-blooded animals, to highly toxic

TABLE 2.—*State Laws and Regulations Relating to the Use of Pesticid Generally (1965)*

State	Products covered					Users covered [1]		Licenses or permi required [1]		
	Insecticides	Fungicides	Herbicides	Rodenticides	Others	Aerial applicators	Ground applicators	Aerial applicators	Ground applicators	Others
Alabama	X	X	----	X	(2)	Cu	Cu	Cu	Cu	----
Arizona	X	X	X	X	(3)	All	Cu	All	Cu	----
Arkansas	X	X	X	X	------	Cu	Cu	Cu	Cu	----
California	X	X	X	X	------	All	All	All	All	(4)
Colorado	X	X	X	----	(3 5)	Cu	Cu	Cu	Cu	----
Connecticut	X	X	X	X	(6 2)	All	Cu	All	Cu	(7)
Florida	X	X	X	X	------	------	Cu	------	Cu	----
Hawaii	----	----	X	----	------	All	All	All	All	(4 8)
Idaho	X	X	X	----	------	Cu	Cu	Cu	Cu	----
Illinois	----	----	X	----	------	(9)	(9)	(9)	(9)	(9)
Indiana	X	X	X	X	(6)	All	------	All	------	----
Iowa	X	X	X	X	------	Cu	Cu	Cu	Cu	----
Kansas	X	X	X	X	------	All	Cu	All	Cu	----
Kentucky	X	X	----	X	------	------	Cu	------	Cu	----
Louisiana	----	----	X	----	------	All	All	All	Cu	----
Massachusetts	----	----	X	----	(10)	------	------	------	------	(10)
Michigan	X	X	X	X	------	Cu	Cu	Cu	Cu	----
Minnesota	X	X	X	X	------	All	Cu	All	Cu	----
Mississippi	X	X	X	X	(2)	All	Cu	All	Cu	----
Nevada	X	X	X	X	(6)	Cu	Cu	Cu	Cu	(6)
New Hampshire	X	X	----	----	------	Cu	Cu	Cu	Cu	----
New Mexico	X	X	X	X	------	------	Cu	------	Cu	----
New York	----	----	X	----	(9 10)	------	------	------	------	(9 10)
North Carolina	X	X	X	X	------	All	-----	All	------	----
North Dakota	X	X	X	X	(6)	All	------	All	------	----
Ohio	----	----	X	----	------	(9)	(9)	(9)	(9)	(9)
Oklahoma	X	X	X	X	(3)	Cu	Cu	Cu	Cu	----
Oregon	X	----	X	----	------	All	All	All	All	(4)
Rhode Island	X	X	X	X	------	Cu	Cu	Cu	Cu	----
South Dakota	X	X	X	X	------	All	Cu	All	Cu	----
Tennessee	X	X	----	X	------	Cu	Cu	Cu	Cu	----
Texas	----	----	X	----	------	All	All	All	All	(4 8)
Utah	X	X	X	----	------	All	Cu	All	Cu	----
Vermont	X	X	X	X	------	All	------	All	------	----
Washington	X	X	X	X	(3 5)	All	All	Cu	Cu	----
Wisconsin	X	----	----	----	------	(10)	(10)	(10)	(10)	(10)
Puerto Rico	----	----	X	----	------	(9)	(9)	(9)	(9)	(9)

[1] All=All users (those treating their own land and custom applicators); Cu Custom applicators only.
[2] Sprays or methods used to improve the condition of trees.
[3] Plant-growth regulators and defoliants.
[4] Owner of land treated.
[5] Nematocides.
[6] Fertilizers and seeds.
[7] Tree experts.
[8] Manufacturers and dealers.
[9] Director of Department of Agriculture has authority to restrict use. See statut
[10] Pertinent only to application of chemicals to water and to noncrop areas. S statute.

ompounds, such as strychnine and icotine. Most of these compounds re readily absorbed through the igestive tract or respiratory sys-em and some through the skin as ell. The most common troubles ncountered in the use of many of ne plant derivatives consist of der-natitis, irritation to the eyes, and ritation to nasal membranes. hese troubles are fairly common mong individuals who are sensi-ve to these compounds. The ymptom produced most often by ctual poisoning is stimulation of he nervous system, leading to con-ulsions and paralysis in severe oisoning. However, trouble in-olving pyrethrins, rotenone, and ther plant derivatives that are low n toxicity results from individuals' eing allergic rather than from the irect toxicity of the compounds.

CHLORINATED HYDRO-CARBONS

General description and use.— his group of chemicals includes a rge number of insecticides and a mited number of herbicides that ave been introduced since World Var II. Their use as insecticides aries widely as does their toxicity o warm-blooded animals. DDT is ne of the most widely used and per-aps the best known chemical in this roup. Because the symptoms of oisoning and the mode of action ay differ between the various hemicals of this group, the follow-ng discussion will be based largely n DDT as an example. DDT is eadily absorbed through the diges-tive tract and respiratory system. Dry formulations of DDT are not absorbed through the skin to any significant degree; however, certain liquid formulations are readily absorbed through the skin.

Many of the other chemicals in this group are readily absorbed through any of these portals. These chemicals act on the central nervous system; however, the exact manner in which they do so is not clearly understood.

Many of the chlorinated hydrocarbons are readily stored in body fat when absorbed either in a single large dose or in repeated smaller doses. The chemicals stored in the fat appear to be largely inactive, because the total amount stored in an experimental animal may be greater than the amount required to cause death if given as one dose. They are gradually eliminated from body fat when further absorption is discontinued. Elimination from the body fat is largely through urine and feces, although some is through milk or perspiration.

ORGANIC PHOSPHORUS COMPOUNDS

General description and use.— Many of the modern pesticides that are derived from phosphoric acid are known as organic phosphorus compounds. These chemicals are used primarily as insecticides; they have some use as nematocides and as plant defoliants. The different compounds vary widely in effectiveness against a given pest. In general, organic phosphorus compounds kill insects quickly, and the

residues left from the treatment dissipate rapidly.

Relative toxicity and mode of action.—The toxicity of organic phosphorus compounds varies from malathion, which is relatively low in toxicity, to tepp (tetraethyl pyrophosphate), which is extremely toxic. Most chemicals in this group are readily absorbed through the skin, digestive tract, or respiratory system, or all of these.

Even though these chemicals have a wide range in toxicity levels, they can be used safely by applicators who recognize poisoning symptoms and heed the precautions given on the pesticide container label.

The organic phosphates affect the nervous system when absorbed into the body in significant amounts. The main action is the lowering of the cholinesterase in the body.

Because many of the symptoms of poisoning appear before the blood cholinesterase level drops, or may persist after the cholinesterase level has returned to normal, you must know these symptoms. At first, the affected person shows a loss of appetite, nausea, vomiting, abdominal pain or cramps, sweating, tears, salivation, pinpointing of the pupils of the eye, and a mild headache. When the degree of poisoning is somewhat greater, there is severe headache, heart spasm, shortness of breath, tight chest, paleness or even a bluish skin, and a loss of sphincter control.

Because of the similiarity between the symptoms caused by a decreased cholinesterase and the symptoms of other diseases, the doctor may diagnose an affected person as having summer flu or a heat stroke. To prevent confusion, wear some sort of identification, such as a dog tag identifying you as one who works with organic phosphorus compounds. Be certain that a record of any contamination and any treatment in the field accompanies the affected person so that the doctor may more intelligently treat him.

The use of atropine minimizes all these effects. Symptoms that are not affected by atropine include nervousness and twitching of the tongue, eyelid, face, neck, and eye muscles. In patients who are severely poisoned without successful treatment, these symptoms are followed by weakness, flaccidity, and paralysis. No treatment is effective. Finally, the brain is affected with initial stimulation, followed by deep depression, severe headache, giddiness, tension, apprehension, foreboding, tremors, drowsiness, mental confusion, slurring of speech, convulsions, coma, and death.

Different chemicals in this group vary in the length of time required for poisoning when absorbed through the skin. For example, tepp, phosdrin, and para-oxon in the same amounts required to cause death when taken by mouth can cause death in 10 to 30 minutes when placed on the skin. Parathion, diazinon, and certain others in this group must be converted in the body to the toxic compound, and death may occur as late as 24 to 48 hours after contamination. Knowledge of the time required to cause symptoms and death is, of course, of vital importance to the physician.

Alcohol increases the effects of phosphorus poisons. The effects of alcohol are depressing, as are the effects of the poisons, and a person who has been taking alcohol is much more susceptible to the effects of organic phosphate poisoning.

CARBAMATES

General description and use.—Several of the modern fungicides, herbicides, nematocides, and insecticides are in this group. One of the most widely used and perhaps the best known is carbaryl (Sevin), which is widely used as an insecticide and to a limited extent as a plant regulator. Carbaryl is highly toxic to bees, and you should take care to avoid application in areas where bee activity is high. Notify beekeepers near the area to be treated in advance of the application of this insecticide. In addition to the insecticide carbaryl, the chemicals in this group that are likely to be applied by aircraft include the fungicides ferbam, maneb, nabam, zineb, and ziram.

Relative toxicity and mode of action.—The carbamates are generally low in toxicity to warm-blooded animals when compared to certain chemicals in the chlorinated hydrocarbon and organic phosphorus group.

Carbaryl is readily absorbed through the skin, digestive tract, or respiratory system.

These chemicals act as inhibitors of cholinesterase in the same manner as explained for the organic phosphorus compounds. However, the action of carbamates on cholinesterase is much shorter in duration than that of organic phosphorus. For this reason, normal levels of cholinesterase in the blood can be restored much faster, and measurements of blood cholinesterase may appear normal a short time after poisoning. Carbamates are readily metabolized in the body and do not accumulate as do certain chlorinated hydrocarbons.

Signs and symptoms of poisoning are not as clearly defined as in organic phosphorus compounds or the chlorinated hydrocarbons. If absorbed in amounts sufficient to cause acute poisoning, symptoms produced by carbamates include constriction of the pupils, salivation, muscular incoordination, and cramps, followed by profuse sweating. In acute poisoning, atropine sulfate is the antidote and recovery usually is rapid and complete. Field experience with carbamates has been relatively free from accidental poisoning.

PHENOXY HERBICIDES

General description and use.—This group is often referred to as growth regulator herbicides and includes such chemicals as 2,4-D, 2,4,5-T, Silvex, and MCPA. These are available as acids; however, they are more commonly used as esters or salts. The derivatives vary in form as well as in action as herbicides. The esters are, in general, volatile. Do not use them close to beneficial crops or plants that are susceptible to their action. The salts have no herbicidal volatility and there is no danger from vapor drift. In addition to their use as herbicides, these chemicals

are used to a limited degree as plant regulators.

Different plants vary widely in susceptibility to this group of herbicides.

Relative toxicity and mode of action.—The chemicals in this group are generally low in toxicity to warm-blooded animals. They are readily absorbed through the digestive tract and possibly through the respiratory system. They are not absorbed through the skin to any appreciable extent. Although these chemicals disrupt the physiological functions of certain plants, their presence does not affect hormones in animals. The exact manner in which the phenoxy herbicides act in the animal or human body is not clearly understood.

The oral dose required to produce symptoms of poisoning in man is estimated as 3 to 4 grams of the active chemical. These chemicals are readily eliminated from the body, and recovery seems to be rapid and complete. Occasionally, an allergic individual may have dermatitis if exposure is continued.

ARSENIC

General description and use.—Several arsenic compounds have been widely used as insecticides, herbicides, and rodenticides. Arsenic has been used as a pesticide for more than 200 years and still is used extensively in some areas. Its use as an insecticide has declined since the introduction of chlorinated hydrocarbons and organic phosphorus compounds. However, its use as a herbicide has increased in recent years.

Relative toxicity and mode of action.—Arsenic compounds, in general, possess a high degree of toxicity to warm-blooded animals. However, this toxicity varies with the solubility of the arsenic and the formulation of the pesticide product. Some organic arsenic compounds are relatively low in toxicity. Arsenic is absorbed chiefly through the respiratory system and digestive tract. However, some arsenic is absorbed through the skin, especially when the skin is broken, as in eczema or other forms of dermatitis. When absorbed into the bloodstream, arsenic acts as a protoplasmic poison. It tends to block the capillaries and prevent enzymes and oxygen from reaching the tissues. This action is strongest in the intestines, regardless of the route of absorption of arsenic.

Arsenic is responsible for more accidental poisoning than any other chemical and has been for many years. The signs and symptoms of arsenic poisoning are abdominal pain and vomiting. These often start within an hour after ingestion the speed of action depending on the amount ingested. In severe poisoning, death may be delayed 1½ to 3 days, and sometimes as long as 14 days. The victim of arsenic poisoning experiences severe dehydration similar to that caused by cholera, and death often results from a severe drop in blood pressure. If the victim recovers from arsenic poisoning, he may experience severe dermatitis or neuritis accompanied by pain and tenderness of the limbs. Persons who are continuously exposed to arsenic are

kely to have small amounts stored
i the liver and kidneys and espe-
ially in the hair. Arsenic is gradu-
lly excreted through the urine.

Formulations

Proper formulation of agricul-
ural chemicals increases their effec-
veness and may change the hazard
o applicators and handlers. Drift
otential is affected by the formula-
on. Difference in formulation of
chemical may change its solubil-
y, volatility, specific gravity, tox-
ity to plants, and numerous other
haracteristics. The addition of
ther substances, such as surface-
ctive agents (surfactants), may
lter considerably the effectiveness
f an agricultural chemical.

Agricultural chemicals are for-
ulated to be applied as solutions,
mulsions, suspensions, granules,
nd dusts.

SOLUTIONS

A solution is a physically homo-
eneous liquid mixture of two or
ore substances. The salts of many
hemicals are soluble in water. For
xample, the sodium and amine
lts of 2,4-D, 2,4,5-T, and silvex
n be dissolved in convenient
mounts of water for spraying.
imilarly, the active chemical form
f some chemicals is oil soluble. For
xample, chemicals insoluble in
ater, such as aldrin, heptachlor,
nd malathion, may be dissolved in
il for application. Two or more
ifferent chemicals sometimes may
e dissolved in the same solvent for
imultaneous spray application.
owever, some chemicals when so
dissolved in the same solvent form
precipitates that will clog sprayer
filters and nozzles. To avoid this,
mix a small quantity of the chem-
icals in the solvent in the same pro-
portion as that to be used in the
final spray mixture and observe for
precipitates before mixing a large
amount in the sprayer.

SUSPENSIONS

Suspensions usually consist of a
finely ground wettable powder dis-
persed in a liquid. Some chemicals
are nearly insoluble in both water
and oillike substances, and concen-
trated solutions and emulsions can-
not be prepared. Many of these
chemicals can be finely ground and,
with the addition of a surfactant,
can be dispersed in water and oil
carriers. Such suspensions usually
have a "cloudy" appearance.

Most suspensions require agita-
tion to prevent settling of the solid
particles. The smaller the solid
particle, the slower the rate of set-
tling. If the solid particles have
about the same specific gravity as
the liquid, the rate of separation is
reduced.

Agricultural chemicals formu-
lated as wettable powders include
carbaryl, DDT, malathion, para-
thion, atrazine, and monuron.

EMULSIONS

Emulsions are formed by the dis-
persal of one liquid in another, with
each maintaining its original iden-
tity. Agitation usually is required
to promote emulsification and to
prevent separation. Choosing liq-
uids of approximately equal den-
sity reduces the tendency to sepa-

rate. Surfactants usually are required to facilitate emulsification, which makes possible the mixing of reactive chemicals without forming precipitates.

Oil-soluble chemicals often are formulated so that they form emulsions when vigorously agitated in water. For example, ester formulations of 2,4-D and 2,4,5-T and emulsifiable concentrates of DDT, parathion, and others usually are mixed with water to form oil-in-water emulsions. Emulsions appear "milky."

Water-in-oil emulsions of varying viscosity can be prepared with special surfactants. These often are referred to as invert emulsions. When the proportion of water to oil is increased, the liquid becomes more viscous. By carefully controlling the proportions of water and oil in invert emulsions, we can prepare sprayable viscous liquids. Special equipment usually is required for dispersing invert emulsions. Invert emulsions may reduce the amount of spray drift.

DUSTS

Finely ground chemicals, either alone or mixed with finely ground diluents, are dispersed for control of insects and plant diseases. Because of the drift hazard, herbicides are not applied as dusts.

The relative effectiveness of dusts versus sprays depends on several factors, including the kind of chemical, pests involved, wind, and type of crop. Some fungicides are more effective in dusts than in liquid form; the reverse is true with some other chemicals. Therefore, make the decision to apply dust or spray formulations after considering the relative effectiveness of the individual chemicals and the relative hazards involved.

GRANULES

These are formed by impregnating coarsely ground dry carriers such as attapulgite clays, vermiculite, or other inert material, with the chemical. Such formulations should be dust free and usually involve little or no drift hazard, and residues remaining on plants may be reduced because most of the material falls directly to the soil. Granular agricultural chemicals are usually effective against the organisms on or in the soil. Certain ones are absorbed by the plant and are effective through systemic action.

BAITS

Baits are prepared by mixing insecticides with various carriers and an attractant that will cause the insects to eat the poisoned bait. Equipment for applying baits is similar to that used for applying granular formulations.

Selection

RELATIVE HAZARDS

When you select a material, consider the relative toxicity of agricultural chemicals that can be used to accomplish the control objective. Choose an effective chemical that minimizes hazards to operators, to nearby crops, to farm animals and wildlife, and to the consumer of the product being treated.

Chemicals in concentrated form re more hazardous to applicators nd handlers than when diluted. Handle concentrates with the utmost care. Know the precautions nd follow them.

Of all agricultural chemical ormulations used, dust is the most ifficult to contain and to conrol. It "billows up" in handling. t settles on everything, including ne skin of operators, and may be nhaled by handlers. It drifts to eighboring nontarget areas and rops. Use dust only when the toxcity hazard is relatively low and hen the chemical is more effective n this than in other forms. Beause of the nature and hazards inolved, follow to the letter the pecific instructions outlined for the arious dust formulations.

Usually, the oil-soluble formulaon of a specific chemical is more azardous to operators than the ater-soluble formulation, because is more readily absorbed through ne skin. Insoluble formulations re less hazardous than waterluble materials.

EFFECTIVENESS

The effectiveness of specific hemicals varies with the organisms be controlled, their stage of rowth and growth activity, the climatic conditions, and the vegetation n the area that may intercept the hemical. A chemical may be effecve against one organism or group f organisms, but completely ineffective against others. For instance, Mexican bean beetles may nrive on insecticides that wipe out grasshoppers, whereas seed-corn maggots may need still another kind of treatment. DDT for control of aphids on potatoes in Oregon gave poor results—67 to 73 percent control. Against leafhoppers on Russian thistle in southern Idaho, it gave 99 percent control. Therefore, it is important to know the organisms to be controlled in selecting your chemical.

Of equal importance, the time of application or stage of development of the organism to be controlled may influence selection. For instance, one herbicide may be effective for controlling weeds if applied after the weeds emerge. For others, the reverse may be true. Similarly, some contact herbicides are effective as foliage sprays only when the temperatures are high but are less effective under high temperatures when used as soil-applied preemergence herbicides. You must be completely familiar with the chemicals you are using, the organisms you are attempting to control, and the precautions required in the safe use of the specific chemical.

PERSISTENCE

It cannot be said categorically that persistent herbicides should or should not be used. Obviously, the the more persistent the herbicide, the more difficult it will be to correct mistakes in application and to eliminate the chemical from the soil once it is applied. At the same time, the hazards associated with repeated applications of less-persistent chemicals over a period of time to give continued control of organisms may exceed the hazard

of making a single application of a more persistent chemical. In making such decisions, base them on information resulting from research on the relative effectiveness of the various chemicals available, the potential good results from their use, and their potential hazards. If a single treatment of a short-lived chemical will solve the problem at hand, then it is obvious that the chemical has advantages.

RESISTANCE

Continued use of a single chemical may result in selectively developing a population of organisms that are resistant to it. If more than one chemical is effective against an organism, alternation of materials may delay or prevent development of resistant strains. The same portion of an insect population seldom is resistant to two or more classes of chemicals.

COMPATIBILITY

Combinations of some kinds of chemicals result in injury to the crop. For instance, substituted urea herbicides and certain systemic organic phosphorus insecticides may result in poor stands of cotton under some conditions. Therefore, it is important to know the interacting effects of chemicals applied to crops. However, it often is possible to apply two or more kinds of chemicals at the same time if they are compatible. For instance, you may be able to apply a mixture of a fungicide and an insecticide and thus reduce the overall cost of controlling diseases and insects.

In addition to verifying the com patibility of such chemicals for specific use, you must know if th two agricultural chemicals will pr cipitate or cause other trouble applied in mixture. If there is an question, mix a small quantity the two chemicals in the same pr portions to be used in the spra application. If, after the mixtu stands for a time, no precipita forms or other obvious bad effe appears, you may assume that yo can mix the chemicals for appl cation.

EFFECT ON NONTARGET ORGANISMS

Minute quantities of some chem cals may kill plants or cause e treme growth abnormalities an may leave prohibited residues o food crops in nearby areas. A ways take precautions to prever drift that will cause economic lo in neighboring areas and that ma result in damage claims against yo

Rate of Application

Best results will require using th minimum suggested rate that wi give satisfactory control. Ove application may result in plant in jury and certainly will increase th risk of illegal residues on food crop and the hazards to animals an wildlife in the target area. Appl ing less than the recommended rat will result in poor control of pest Follow the instructions on the con tainer label and the advice of loca agricultural authorities when yo decide on the rate to use.

Limitation or Restriction

Illegal residues may persist in rops if you apply chemicals too ıear harvesttime. Tolerances for pecific crops are established on the ›asis of directions requiring a mini-ıum number of days that must elapse between the last treatment and harvest. This information appears on the container label. Comply with these restrictions.

Tolerances for a given chemical may vary for different crops or, in fact, the chemical may not be approved for some crops. Therefore, be sure that the proposed use appears in the recommendations on the label.

PRECAUTIONS

Know Common Antidotes and Safety Measures

Because you are likely to be ex-›osed frequently to small amounts f pesticides that may have an ac-umulative effect, you should de-elop certain safety habits. Some eneral considerations that should e a part of your daily routine are—

Pesticides are poisonous to man nd animals. Use them only when eeded and handle them with care. ollow the directions and heed all recautions on the labels.

Avoid repeated or prolonged con-ıct of pesticides with the skin. .void inhalation of pesticide dusts r mists.

Always wear protective clothing ıd respiratory devices as stated on ıe label. Make sure they meet the ›quirements as described on the .bel.

Wash your hands and face before ıting or smoking and immediately ter completing pesticide applica-on.

Keep soap and water available at ıe landing strip or loading area. Change clothing regularly and equently.

Avoid spilling pesticide on your skin, and keep it out of the eyes, nose, and mouth. If any is spilled on clothing or skin, change clothing immediately and thoroughly wash exposed skin with soap and water.

- Keep pesticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and pets cannot reach them.
- To protect fish and wildlife, do not contaminate lakes, streams, or ponds with pesticide. Do not contaminate wells or other drinking water. Do not clean spraying equipment or dump excess spray material near such water.
- To minimize losses of honey bees and other pollinating insects, make pesticide applications, when possible, during hours when the insects are not visiting the plants. Avoid drift of pesticides into bee yards.
- Empty containers are particularly hazardous. Burn empty bags and cardboard containers in the open or bury them. When you burn them, make sure the smoke will not drift over nearby homes, persons, or livestock. (Some municipalities have restrictions against burning—consult the local

authorities.) Crush and bury bottles or cans.

Locate Poison Control Centers

Many communities and practically all larger cities have a poison control center. These centers have information readily available on antidotes or first-aid actions to be taken in poisoning cases. Know the location and phone numbers for poison control centers in your working areas, so you can tell physicians where added information on treatment may be available. Report accidental poisoning cases to the nearest center.

Read the Label

A chemical that has been registered as described earlier will bear a label that is the best available guide to safe and proper use. Always read the label on the container before applying any chemical and follow its instructions carefully. Give special attention to warnings and cautions that tell you to store the product, how to handle it, and how to apply it safely. The label also will tell if there is a need for using a respiratory device with a reference to information on the type needed for the particular chemical. Further information on respiratory devices for protection against certain chemicals may be obtained from the U.S. Department of Agriculture, Washington, D.C. 20250.

These warnings and cautions on the label will list needed first-aid treatments and antidotes that should be applied to a victim of accidental poisoning. These first-aid treatments and antidotes vary considerably between the different chemicals and sometimes between different formulations of the same chemical. Therefore, it is impractical to attempt to list them in this handbook. Whenever they are required, they will be listed on the chemical label; read the instructions on the container label and be prepared to follow them.

Because you may be exposed to chemicals within the enclosure of the cockpit, be aware of all significant warning symptoms of poisoning. Although the precautions on the label are adequate when followed to prevent injury to the ground handler, the fact that exposure within the cockpit is unique requires that certain additional precautions must be taken by the aerial applicator. Blurred vision, watering of the eyes, or other symptoms as described earlier are of vital importance to you. When you first notice such symptoms, stop flying immediately and wait until such symptoms are completely relieved before resuming.

Remember that many agricultural chemicals are poisonous. Therefore, consider them in the same way you consider loaded guns. They can be used to kill pests, but they are never to be handled or used carelessly. Many aerial applicators have used toxic compounds for many years without incident, because they have always treated these poisons with the respect they deserve.

Additional information on the safe use of pesticides may be obtained from your county agricultural agent.

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METHODS OF SOIL AND PLANT ANALYSIS

With Special Reference to Strontium 90 Contamination

Agriculture Handbook No. 288

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

CONTENTS

	Page
Preparation of samples	1
Ammonium acetate extraction of soil	2
Ashing of plant material	3
Determinations on ammonium acetate extracts of soil and solutions of plant ash	4
Calcium and magnesium	4
Strontium by flame photometry	8
Strontium by X-ray fluorescence emission spectrometry	12
Sodium and potassium	13
Determinations on separate samples	14
pH of soil	14
Organic matter content of soil	15
Exchangeable hydrogen	16
Available and fixed strontium 90 in soils	17
Strontium 90 in plants	22
Literature cited	23

Washington, D.C. Issued August 1965

METHODS OF SOIL AND PLANT ANALYSIS

With Special Reference to Strontium 90 Contamination

By W. R. Heald, R. G. Menzel, H. Roberts, Jr., and M. H. Frere, *Soil and Water Conservation Research Division, Agricultural Research Service*[1]

This handbook contains procedures for determining soil properties necessary to the uptake of strontium 90 from soil by plants. By these methods can be determined the amount and kind of exchangeable cation, pH, and amount of organic matter in soil, as well as the amount of major cation and strontium content of plants. The application of the analytical results obtained is not discussed, because it depends primarily on the purpose for which the samples were taken.

The procedures were taken directly from the literature or were developed in part or entirely by the U.S. Soils Laboratory. Caution should be used in universally applying these procedures, since some of them were developed for specific materials. This is especially true for strontium determination, both natural and radioactive, in that interference from other elements might have different effects on materials other than plants and soils.

PREPARATION OF SAMPLES

Soil samples are prepared for determination of exchangeable alkali and alkaline earth cations by extraction with ammonium acetate. Separate soil samples are used for determination of pH, organic matter content, and exchangeable hydrogen. A much larger sample is used for determination of available and fixed strontium 90.

Spread the field sample (at least 10 pounds) of soil on heavy paper and allow to dry until it can be crushed and sieved easily. Sieve the soil through a quarter-inch mesh screen. Mix before subsampling by rolling on a large sheet of paper. Discard large roots, rocks, and other extraneous material after weighing.

Samples of plant materials should be dried for preservation and better subsampling. Air-drying may be satisfactory, but drying in a forced-draft low-temperature oven (below 70° C.) is preferred. Air-dried samples require a moisture determination and, in some cases, certain parts of the plant will not dry in a reasonable time. Cutting thick plant parts such as petioles, stems, or roots into small segments or slices will greatly increase their drying rate. Unless the

[1] The preparation of this handbook was supported in part by the U.S. Atomic Energy Commission.

entire sample is to be analyzed, the plant material must be finely ground to facilitate proper subsampling. Also, the organic fraction of the plant material is much easier to destroy if the sample is finely divided. The grinding is usually done in a Wiley mill [2] or similar apparatus, using a 30- or 40-mesh screen.

Plant materials are prepared for analysis by dry combustion. This is recommended because large samples are usually required for determination of strontium 90 and they are much easier and safer to handle by dry combustion. The determination of alkali and alkaline earth cations may be made on aliquot parts of the sample taken after the ash has been dissolved.

Ammonium Acetate Extraction of Soil

Equipment

(1) Carboy—18 liters.
(2) Erlenmeyer flask—250 ml.
(3) Mechanical shaker.
(4) Suction flask—1 liter.
(5) Büchner funnel—No. 1 (5.6-cm. inside diameter).
(6) Filter paper—Whatman No. 42 or equivalent (5.5-cm. diameter).
(7) Spatula.
(8) Beaker—400 ml.
(9) Fluted watchglass.
(10) Hotplate.
(11) Volumetric flask—100 ml.

Reagents

(1) Neutral ammonium acetate (NH_4OAc), 1 *N*: Mark the carboy at the 18–liter level. Fill it three-fourths full with distilled water. Add 1,037 ml. of concentrated acetic acid (HOAc) and 1,215 ml. of concentrated ammonium hydroxide (NH_4OH). After mixing and cooling this solution, measure the pH of a small aliquot. If acid, return the aliquot to the carboy and add 5 to 10 ml. of concentrated ammonium hydroxide, mix thoroughly, and take the pH reading again. Decrease the amount of ammonium hydroxide used as the pH approaches 7. If the solution is basic, add small increments of concentrated acetic acid in place of ammonium hydroxide. If the solution is only slightly basic, bubbling air through the solution for several hours usually lowers the pH to 7. Dilute to a volume of 18 liters.

(2) Nitric acid (HNO_3)—concentrated, reagent grade.
(3) Perchloric acid ($HClO_4$)—concentrated, reagent grade.
(4) Nitric acid, 0.1 *N*: Dilute 114.5 ml. of concentrated nitric acid and make up to 18 liters in a carboy with distilled water.

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[2] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

Procedure

Put 25 g. of the sieved sample into a 250-ml. Erlenmeyer flask; add 100 ml. of 1 *N* neutral ammonium acetate, stopper, and let stand overnight. Larger amounts of soil should be extracted if the texture is very sandy or if the soil is very acid. Increase the amount of soil proportionately as the amount of extracting solution is increased. For best results, mix the sample by frequent shaking, either by hand or in a mechanical shaker.

Set in place a 1-liter suction flask and a Büchner funnel containing a circle of Whatman No. 42 filter paper, 5.5 cm. in diameter. Add a small amount of water to the funnel and apply suction until the paper is set. Do not allow the paper to become dry. Rapidly swirl the soil and ammonium acetate mixture. Pour enough of this mixture on the set filter paper to just cover the paper, allow to stand for a few seconds, and then turn on the suction. When this solution has been pulled through, add the rest of the suspension rapidly. If this procedure is done carefully, the filtrate will be clear. If the filtrate is cloudy, turn off the suction and pour the filtrate back in the funnel. This may have to be done several times with some soils. Mix the remaining suspension in the flask and add to the Büchner funnel when possible. Soil allowed to become dry may develop cracks and consequently will not leach properly. If cracks develop, use a spatula to close them before adding more liquid.

Rinse the Erlenmeyer flask with small amounts of ammonium acetate and add the rinse to the Büchner funnel when no more liquid is standing on the soil, but before it becomes dry. Continue rinsing until 250 ml. of leachate is collected in the suction flask. Allow the soil to drain well before stopping suction.

Pour the leachate into a 400-ml. beaker and rinse the suction flask several times with distilled water, adding the rinses to the beaker. Cover the beaker with a fluted watchglass. Evaporate the solution to dryness on a hotplate. When the material is dry, add 20 ml. of concentrated nitric acid and 5 ml. of concentrated perchloric acid and evaporate to dryness again. One acid treatment should destroy the organic matter. If not, again add 10 ml. of concentrated nitric acid and 2 ml. of concentrated perchloric acid and evaporate to dryness. When the beaker is cool, add about 50 ml. of 0.1 *N* nitric acid, which should dissolve most of the solids. Filter through Whatman No. 42 filter paper into a 100-ml. volumetric flask. Wash the beaker and residue with small amounts of 0.1 *N* nitric acid until almost 100 ml. of solution is collected in the volumetric flask. Make to volume with distilled water and mix thoroughly.

Ashing of Plant Material

Equipment

(1) Porcelain evaporating dish—No. 9 (265-mm. diameter).
(2) Electric muffle furnace, with automatic temperature control.
(3) Watchglass (12-inch diameter).
(4) Hotplate.
(5) Funnel—long stem (100-mm. outside diameter).

(6) Filter paper—Whatman No. 42 or equivalent (18.5-cm. diameter).
(7) Volumetric flask—500 ml.
(8) Erlenmeyer flask—250 ml.

Reagents

(1) Hydrochloric acid (HCl)—concentrated, reagent grade.
(2) Hydrochloric acid, 1 *N*: Dilute 85 ml. of concentrated hydrochloric acid to a volume of 1 liter with distilled water.

Procedure

Ash the plant material in an electric muffle furnace at 550° C. for 16 hours. Two hundred grams of plant material can conveniently be ashed in a No. 9 porcelain evaporating dish. The ash should be white if oxidation of the organic material is complete. Gray or dark-colored ash indicates incomplete oxidation. Remuffling after cooling and aeration will oxidize the sample more completely.

Place a 12-inch watchglass on the porcelain dish, leaving a small opening through which enough distilled water is added to moisten the ash. Then add concentrated hydrochloric acid to cover the ash. This procedure minimizes loss of ash caused by splattering. After the reaction has subsided, rinse the material on the watchglass into the porcelain dish. Place the uncovered dish on the hotplate and evaporate carefully to dryness. Cool and dissolve the sample with several hundred milliliters of 1 *N* hydrochloric acid. Filter through Whatman No. 42 filter paper, using a long-stem funnel. Wash the dish and undissolved material collected on the filter paper with additional 1 *N* hydrochloric acid until a volume of 500 ml. is collected in the volumetric flask. Discard the undissolved residue.

Put a 100-ml. sample from 500 ml. of the ash extract in a 250-ml. Erlenmeyer flask. Keep for determination of alkali and alkaline earth cations. The remaining 400 ml. is used for the determination of strontium 90.

DETERMINATIONS ON AMMONIUM ACETATE EXTRACTS OF SOIL AND SOLUTIONS OF PLANT ASH

Calcium and Magnesium

Equipment

(1) Pipets—1, 5, 15, and 20 ml.
(2) Beakers—250 ml.
(3) Microburet.
(4) Fluorescent lamp.
(5) Magnetic stirrer and stirring bar (optional).
(6) pH meter.
(7) Hydrion paper.
(8) Funnel—long stem (7.0-cm. outside diameter).
(9) Hotplate.
(10) Filter paper—Whatman No. 42 or equivalent (5.5-cm. diameter).

Reagents

(1) Standard calcium solution: Dissolve 0.5004 g. of special "low magnesium" reagent grade calcium carbonate ($CaCO_3$), dried at 150° C., in 5 ml. of approximately 6 *N* hydrochloric acid (HCl) and dilute to a volume of 1 liter. This solution is 0.005 molar.

(2) Buffer solution: Dissolve 67.5 g. of ammonium chloride (NH_4Cl) in 200 ml. of distilled water, add 570 ml. of concentrated ammonium hydroxide (NH_4OH), and dilute the solution to a volume of 1 liter with distilled water.

(3) Masking reagents (each of the following solutions must be stored in separate containers):

(a) Cyanide solution: Dissolve 1 g. of potassium cyanide (KCN) in 100 ml. of distilled water.

(b) Hydroxylamine-hydrochloride solution: Dissolve 5 g. of hydroxylamine-hydrochloride ($NH_2OH \cdot HCl$) in 100 ml. of distilled water.

(c) Potassium ferrocyanide solution: Dissolve 4 g. of reagent grade potassium ferrocyanide ($K_4Fe(CN)_6 \cdot 3H_2O$) in 100 ml. of distilled water.

(d) Triethanolamine—reagent grade.

(4) Eriochrome Black T. indicator: Dissolve 0.2 g. of Eriochrome Black T. (EBT) in 50 ml. of methanol. Prepare a fresh solution every 3 weeks.

(5) Standard EDTA solution: Dissolve 1.8613 g. of disodium ethylenediaminetetraacetate (EDTA) (molecular weight=372.254) in distilled water and dilute the solution to a volume of 1 liter. This solution is 0.005 molar. Its titer will change if stored in glass containers but not in polyethylene.

(6) Standard magnesium solution: Dissolve 0.1216 g. of reagent grade magnesium turnings in dilute hydrochloric acid and dilute to a volume of 1 liter. This solution is 0.005 molar.

(7) Calcon indicator: Dissolve 20 mg. of Calcon in 50 ml. of methanol. Prepare a fresh solution weekly.

(8) Sodium hydroxide, 10-percent solution: Dissolve 10 g. of reagent grade sodium hydroxide (NaOH) in 100 ml. of distilled water.

(9) Sodium tungstate solution: Dissolve 20 g. of sodium tungstate ($Na_2WO_4 \cdot 2H_2O$) in 100 ml. of distilled water.

Procedure (*1, 2, 3, 4, 9*) [3]

Standardization of EDTA.—Pipet 5-ml. aliquots of the standard calcium solution into each of three 250-ml. beakers and bring the volume to approximately 150 ml. with distilled water. Pipet 15 ml. of buffer solution, 10 drops of each masking reagent, and 10 drops of EBT indicator. Titrate the solution with EDTA, with stirring, to a permanent blue, using a microburet under a fluorescent lamp. Although stirring by hand is satisfactory, the use of a Teflon-coated magnetic stirring bar activated by a magnetic stirring apparatus is much more convenient. Repeat titration with three 5-ml. aliquots of standard magnesium solution. This standard serves to check the validity of the calcium titration.

[3] Italic numbers in parentheses refer to Literature Cited, p. 23.

The EDTA should also be standardized, using Calcon as the indicator. Pipet three 5-ml. aliquots of standard calcium solution into three 250-ml. beakers and bring the volume to approximately 150 ml. with distilled water. Add 10 drops of each masking reagent, then pipet 1 ml. of 10-percent sodium hydroxide or an amount sufficient to raise the pH to 12 or slightly higher. Check with a pH meter or Hydrion paper. Add 5 drops of Calcon indicator and titrate from a red to a permanent blue with EDTA under the same conditions as above. All microburet readings should agree within 0.05 ml.

Titrate three blanks with each standardization. The EDTA should be standardized every time a new set of samples is to be titrated. This titration not only rechecks the standardization of the EDTA but also indicates the presence of contamination in the microburet, pipets, and beakers.

Calcium Plus Magnesium.—Place an aliquot containing 1 to 2 mg. of calcium plus magnesium in a 250-ml. beaker and dilute to about 150 ml. with distilled water. Pipet 15 ml. of buffer solution and 10 drops of each masking reagent. Allow a few minutes for the reactions to take place, especially for the formation of manganese ferrocyanide. Warming will speed this reaction. Add 10 drops of the EBT indicator and titrate in the same manner and to the same color as when the EDTA was standardized.

If the end point is difficult to obtain, probably too much phosphate is present. (See comments.) To overcome this difficulty, use the following procedure: To a new aliquot, add 10 drops of each masking reagent as before. Add a known excess amount of the standardized EDTA. Experience will indicate the amount of EDTA necessary. Bring the solution to the necessary pH value by adding 15 ml. of the buffer solution. The pH of this solution should be 10. If there is any doubt because of high salt or acid content in the original aliquot, check with the pH meter and add more buffer to bring to pH 10. Heat the solution on a hotplate to near boiling for several minutes to speed up the reaction, cool, add 10 drops of EBT indicator, and titrate from a blue to a permanent red with the standard calcium solution.

Calcium.—Place an aliquot containing 1 to 2 mg. of calcium in a 250-ml. beaker and dilute to a volume of about 150 ml. with distilled water. Add 10 drops of each masking reagent and enough 10-percent sodium hydroxide (usually about 1 ml.) to raise the pH to 12 or slightly higher. Check with a pH meter or Hydrion paper. Add 5 drops of Calcon indicator and titrate the solution from red to blue with standardized EDTA.

If the end point is difficult to obtain because of the presence of phosphate, to a new sample add the masking reagents and a known but an excess amount of EDTA. Bring the pH up slowly to 12 with 10-percent sodium hydroxide. Then heat the solution to near boiling for several minutes, cool it, add 5 drops of Calcon indicator, and titrate the solution from blue to red with a standard calcium solution.

Magnesium.—Place an aliquot containing 2 to 4 mg. of magnesium in a 250-ml. beaker and add enough distilled water to make a total volume of about 100 ml. Pipet 20 ml. each of the buffer solution and sodium tungstate solution. Check with a pH meter and add more buffer solution to bring to pH 10. Heat the beaker and contents for 1 hour without boiling, cool, and filter the contents through Whatman No. 42 filter paper. Wash the paper and precipitate with a solution

containing 50 ml. of buffer solution per liter. Add 10 drops of each masking reagent. Allow a few minutes for the reactions to take place. Add 10 drops of the EBT indicator and titrate from a red to a permanent blue. Heating slightly will speed the magnesium end point.

Calculation of Results.—If the EDTA solution has been carefully prepared from a pure material, the following relationships are true: Each milliliter of EDTA is equivalent to 0.005 mM of cation whether the cation is calcium, magnesium, or the sum of the two. Also, each milliliter of EDTA is equivalent to 0.2004 mg. of calcium or calcium plus magnesium expressed as calcium, or 0.1216 mg. of magnesium or calcium plus magnesium expressed as magnesium.

Since the commercial form of EDTA may contain varying amounts of adsorbed water and other impurities, the following equations are used to calculate the millimoles of calcium plus magnesium, calcium, or magnesium in the bulk sample, depending on the conditions under which the titration was made.

Standardization of EDTA:

$$\frac{\text{(Millimoles of standard cation used in titration)}}{\text{(Milliliters of EDTA}_{\text{standard}}\text{—milliliters of EDTA}_{\text{blank}}\text{)}}$$

$$=\text{concentration of EDTA in terms of millimoles per milliliters}$$

Evaluation of sample:

$$\text{Concentration of standardized EDTA} \times (\text{milliliters of EDTA}_{\text{sample}}\text{—milliliters of EDTA}_{\text{blank}}) \times \text{aliquoting factor} = \text{millimoles of cation in total sample}$$

If an excess of EDTA was added to overcome phosphate interferences, these equations are used to obtain the total millimoles of cation in the sample. From this value subtract the number of millimoles of standard calcium used in the back titration, giving the millimoles of cation originally in the aliquot taken.

The usual procedure is to obtain the millimoles of calcium plus magnesium and then determine the millimoles of either calcium or magnesium. The millimoles of the other cation are obtained by subtraction.

Comments

The nature of the material may make some modifications necessary. The amounts of reagents used are sufficient for most conditions that may be encountered. However, in the presence of large amounts of iron or aluminum, more masking reagents may be required. It may be even necessary to remove a large excess of iron or aluminum by the classical hydroxide precipitation. When abnormally large amounts of phosphate are present, a separation or removal of phosphate is recommended before the titration. Increasing or decreasing the amount of indicator may help some workers to see the end point better.

As little as 10 p.p.m. of phosphate will interfere with the calcium titration. This concentration is rarely found in soil extracts, but it will be commonly found in plant tissue digests, particularly from seeds.

The stability constant of calcium phosphate is less than that of calcium-versenate; therefore, EDTA will dissolve calcium phosphate, but the process is slow. In the procedure generally used, calcium phosphate is formed before sufficient EDTA has been added. In the titration then a permanent blue, which indicates the end point, cannot be maintained while calcium phosphate is dissolving. This makes the titration impractical.

In some rare instances the magnesium concentration may be as large or larger than the calcium concentration, causing a poorly defined color change at the end point when titrating calcium alone. In this case, the calcium indicator is adsorbed on the magnesium hydroxide particles, making the color change many shaded and difficult to see. A protective colloid such as Carbocel may be added to prevent the adsorption of the dye (*10*). It has also been found that if most of the EDTA is added before the pH is raised, the color change at the end point is sharp and easily seen (*7*).

The amounts of extractable or total barium or strontium in some soils may be large enough to interfere. Although calcium may be separated from barium and strontium, the procedures are difficult. Both barium and strontium form EDTA complexes of low stability; therefore, unless their concentrations approach that of calcium, the degree of interference will be small.

Strontium by Flame Photometry

Equipment

(1) Equipment necessary for determining calcium.
(2) Pipets—5 and 10 ml., graduated, blowout type.
(3) Centrifuge tubes—40 ml., heavy duty.
(4) Water bath—2-liter beaker, with metal cover punched out to support centrifuge tubes.
(5) Centrifuge.
(6) Electric muffle furnace, with automatic temperature control.
(7) Fritted glass filter assembly: From a 15-ml., 20-mm. diameter, coarse porosity filter funnel (Corning, type 36060), remove the part above the glass frit with a glass saw and grind level the remaining frit. Cut a 5-cm. chimney from a length of glass tubing (18-mm. inner diameter) and grind one end level. Mount the filter funnel in a suction apparatus, place a filter pad on the fritted glass, and center the ground end of the chimney carefully over the fritted glass. During filtration, the assembly is held tightly together by means of rubber-bands and wire hooks.
(8) Suction apparatus—Nylab filter bell.
(9) Filter paper—glass-fiber or conventional paper (2.1-cm. diameter).
(10) Flame photometer—D.U. Beckman model, with photomultiplier attachment and hydrogen-oxygen burner assembly.
(11) Beakers—5 ml.

Reagents

(1) Strontium standard solutions: A series containing 0, 0.5, 1.0, 2.0, 2.5, 5, 7.5, and 10 p.p.m. of strontium and 500 p.p.m. of calcium is made up in 0. 1 *N* hydrochloric acid. A stock solution of strontium

chloride should be standardized by gravimetric determination of strontium sulfate. Standard calcium solution, as prepared for the determination of calcium (p. 4), may be used to make this series of strontium standards.

(2) Reagents necessary for determining calcium (p. 4).

(3) Hydrochloric acid, approximately 6 *N*: Dilute 500 ml. of concentrated hydrochloric acid (HCl) to a volume of 1 liter with distilled water.

(4) Oxalic acid, 5 percent: Dissolve 100 g. of oxalic acid ($H_2C_2O_4$) in 2 liters of distilled water.

(5) Indicator solution: Phenol red, 0.1 percent in 1:1 ethyl alcohol: Dissolve 0.1 g. of phenol red in 100 ml. of a solution containing 52 ml. of ethyl alcohol and 48 ml. of water. Methylene blue, 0.2 percent: Dissolve 20 mg. of methylene blue in 100 ml. of water. Mix these two solutions at a rate of one part of phenol red and two parts of methylene blue.

(6) Ammonium hydroxide: Dilute 250 ml. of concentrated ammonium hydroxide (NH_4OH) to a volume of 1 liter with distilled water.

(7) Washing solution: To make 1 liter, mix the following ingredients in the proportions given: 20 ml. of concentrated ammonium hydroxide, 326 ml. of distilled water, 326 ml. of ether, and 326 ml. of ethyl alcohol.

(8) Hydrochloric acid, 0.1 *N*: Dilute 17.2 ml. of concentrated hydrochloric acid to a volume of 2 liters with distilled water.

Procedure

The strontium determination is made on a solution containing 500 p.p.m. of calcium, which for convenience should have a volume of about 15 ml. From the following calculations the number of milliliters of soil or plant extract (see Preparation of Samples) needed is obtained.

(1) If milliequivalents of calcium per 100 g. of soil is known,

$$\frac{(\text{milliequivalents of calcium per 100 g. of soil})}{4} \times 20 = \text{milligrams per 100 ml.}$$

$$(\text{milligrams per 100 ml.}) \times 10 = \text{parts per million}$$

$$\frac{500 \times 15}{(\text{parts per million})} = \text{number of milliliters needed.}$$

Therefore,

$$\frac{150}{(\text{milliequivalents of calcium per 100 g. of soil})} = \text{aliquot.}$$

(2) If parts per million of calcium in the extract is known,

$$\frac{7{,}500}{(\text{parts per million of calcium})} = \text{aliquot.}$$

For convenience, take the aliquot to the nearest 0.5 ml. and adjust the final volume to contain 500 p.p.m.

Pipet the calculated aliquot into a 40-ml. centrifuge tube and dilute to about 20 ml. with distilled water. Add 1 ml. of 6 *N* hydrochloric acid and 2 ml. of 5-percent oxalic acid and place in a gently boiling water bath. Remove the tube from the bath after its contents have reached about 90° C. (equilibrium with boiling water bath) and add 5 drops of the mixed indicator solution. Add ammonium hydroxide dropwise, mixing continually with a swirling motion until the solution just changes from a green to a blue. Calcium oxalate should start precipitating shortly after the hydroxide is added. Replace the tube in the boiling water bath for 30 minutes. The addition of small amounts of ammonium hydroxide may be necessary from time to time to keep the suspension slightly basic (just blue). Cool the tube and suspension and centrifuge for 20 minutes at about 1,500 r.p.m.

Decant the supernate carefully and lay the tube on a slant for 10 minutes to facilitate drainage. Wipe the lip of the tube with a tissue to remove the last drops and suspend the oxalate precipitate by stirring with a jet of 5 ml. of washing solution. Centrifuge, decant, and drain once again.

Allow the precipitate to air-dry overnight. Heat the samples at least 1 hour at 525° C. in a muffle furnace. At this temperature calcium and strontium oxalate are converted to carbonates, also any iron or aluminum present is converted to the dehydrated oxides. When the samples are cool, dissolve the precipitate in 0.1 *N* hydrochloric acid. The number of milliliters of hydrochloric acid necessary is calculated to the nearest 0.01 ml. as follows:

$$\frac{(\text{Parts per million of calcium in original sample})}{500} \times \text{aliquot} = \text{milliliters of 0.1 } N \text{ hydrochloric acid required}$$

If iron, manganese, and aluminum were present in the original sample in any appreciable amounts, they will appear as precipitates in the sample and must be removed. The precipitates are easily removed by filtering. The removal is essentially quantitative if done shortly after the carbonate sample is dissolved. A fritted glass filter assembly with suction apparatus is convenient, in that the assembly may be rapidly washed with acid and dried with ether or alcohol between samples. The actual filtering surface may be either glass-fiber or conventional filter paper. Glass-fiber paper has the advantage of retaining little of the liquid fraction.

If the filtered sample is cloudy or colored, the sample should be refiltered or dried and muffled. When a clear solution is obtained, determine the calcium as previously described. If the initial titration or estimation of calcium, pipeting, and precipitation procedure were done properly, the calcium concentration should be 500 p.p.m. If the present titration is not within 20 p.p.m. of 500 p.p.m., the sample must be concentrated or diluted.

A D.U. Beckman photometer is used to estimate strontium in a hydrogen-oxygen flame. Allow at least a 30-minute warming-up period with the selector switch at check. Set the oxygen pressure at 10 p.s.i. and the hydrogen pressure at 3 p.s.i., with the control associated with the instrument, and light the flame. For stability of the pressures, it

is best to have at least 20-p.s.i. pressure showing on the low-pressure gages of the oxygen and hydrogen tanks. Use full photomultiplication and set the switch accordingly. The blue tube is set into position according to the instructions furnished by the manufacturer. Always keep the galvanometer at zero with the dark current control.

The following settings are made initially: Wavelength dial to 460.7 mμ, slit width at 0.03 mm., transmittance reading at 100, and sensitivity control at midpoint. Aspirate several 5-ml. beakers full of water. Place a 5-ml. beaker of the most concentrated standard solution in position to be aspirated. Open the shutter and move the wavelength dial slightly. A deflection of the galvanometer needle to the left indicates that the original wavelength setting was wrong. Adjust until a very slight turn of the dial in either direction results in the galvanometer needle deflecting to the right. Close the shutter after each reading and check the dark current setting.

Produce a standard curve as follows: Set the transmittance dial at 100 and aspirate the most concentrated standard. Zero the galvanometer needle with the dark current control, open the shutter, and zero the needle with the sensitivity control. Close the shutter, remove the sample, and rinse the burner with distilled water for a few seconds. Put the next most concentrated standard solution in position. Make the reading by moving the transmittance dial until the galvanometer needle is at zero. Reset the instrument at 100-percent transmission with the most concentrated standard solution before each new reading is made. Obtain transmittance readings for standards by this process. Plot the transmittance reading against the concentration of the standard and calculate the equation of the line.

Pour the unknown into a 5-ml. beaker and aspirate through the burner assembly for a few seconds. Discard the remainder, refill the beaker, and replace under the flame. Obtain the reading by turning the transmittance dial until the galvanometer needle is at zero. After every six to eight determinations of unknown samples, adjust the instrument with a standard sample in the range of the unknowns.

Comments

Adjustments to be made and precautions to be taken before and during every determination:

(1) Oxygen pressure, 10 p.s.i.

(2) Hydrogen pressure, 3 p.s.i. A change in pressure, as indicated by the width of the hydrogen pressure gage needle, is sufficient to give incorrect measurements.

(3) Dark current must be zero before and after each measurement. If not, measure again.

(4) Any yellowish tint to the flame usually indicates the presence of sodium.

Possible factors contributing to incorrect results are as follows:

(1) Phototube positioning switch not completely in or out.

(2) Plugged burner is usually indicated by aspiration continuing a short time after the solution is removed from the siphon tube. Also, the measurements are approximately the same value. Unplug the burner as follows: Turn off the hydrogen, leaving the oxygen on. Carefully push a wire (found with instrument) up the siphon tube;

never start from the top. If this does not solve the problem, the burner assembly may need repair and should be returned to the manufacturer.

(3) Slit width may have been accidentally changed.

Strontium by X–ray Fluorescence Emission Spectrometry

Equipment

(1) Mortar (agate) and pestle.
(2) Pipet—1 ml.
(3) Glass stirring rod.
(4) Spatula.
(5) Sample holder: Modified so that an aluminum alloy frame, 0.05 inch thick, can be slid into the holder and supported along the edges only. The center of the frame is cut out to match the opening in the holder. The bottom side of the frame is covered with 0.00025-inch Mylar film stretched tight and cemented to the frame with rubber cement. The irradiation beam is carefully centered so that no part of the holder or frame is irradiated.
(6) Microscope slide.
(7) Philips Norelco X-ray spectrograph, with FA–60 tungsten X-ray tube. The X-ray beam excites secondary X-rays from the sample. These are collimated to an analyzing crystal, then to a scintillation detector with linear amplifier and fast scaler. The X-ray tube is operated at 50 kv. and 40 ma.

Reagents

(1) Strontium standard solutions: From a stock solution (see reagents for Strontium by Flame Photometry) prepare dilutions containing 0, 20, 40, 60, 80, 100, 150, and 200 μg. of strontium per milliliter of solution.
(2) Ethyl alcohol (C_2H_5OH)—95 percent.

Procedure

Ash 100 g. of plant material, as described under Preparation of Samples. Record the weight of the ash and transfer the ash to an agate mortar, grind with a pestle, and mix to obtain a homogeneous mixture.

Prepare standard samples in an identical manner, except pipet 1 ml. of standard strontium solution (e.g., 0, 20, 40, 60, 80, 100, 150, and 200 μg. of strontium) into a mortar containing a slurry of 1 g. of ash and 20 ml. of 95-percent ethyl alcohol. Mix the slurry thoroughly with a glass stirring rod, dry overnight at 70° C., and mix thoroughly with mortar and pestle to obtain a homogeneous fine powder.

Transfer the powdered ash with a spatula to the aluminum alloy frame, backed with Mylar film, of the sample holder, level off with the edge of a glass microscope slide, and smooth with the flat side of the microscope slide to give a uniform surface for reflectance. About one-half gram of ash is required to fill the frame. It is not necessary to weigh definite amounts of the sample, nor is it desirable to pack the sample into the frame.

Place the filled frame in the sample irradiation chamber of the spectrograph. Scan the first sample of a series by setting the goniometer to run automatically over the desired range (about 20° or 30° 2θ) in order to obtain a picture of the area for a background and thus avoid choosing an angle for background with interference from other lines, up to the fifth order. The strontium Kα line appears at 25.15° 2θ, whereas the position of 25.90° is usually used for a background reading.

For quantitative analysis, use the peak-to-background ratio (P/B) of intensities as a measure of the strontium concentration. Obtain this ratio by setting the goniometer at 25.15° and recording the time necessary to measure 51,200 counts, then setting the goniometer at the background position (25.90°) and recording the time required for 51,200 counts. Convert the recorded times to counts per second, and calculate the ratio of the counts per second at the strontium peak to the counts per second at the background position.

Prepare a standard curve from measurements of the P/B in samples with added strontium. On the scan that was made, draw a straight line connecting the background on one side of the strontium peak to the background on the other side. Usually the background directly under the peak (25.15°) is higher than the one measured at 25.90°. This difference must be accounted for in determining the unknown amount of strontium originally present in the standard samples. The ratio of the count rate of the background at 25.15° to the count rate at 25.90° is called B/B. Subtract it from the P/B for the samples with added strontium. Then plot the net P/B versus the added strontium. Draw a straight line through the points and extrapolate to the negative X axis, which has the same scale as the positive X axis. This intercept gives the micrograms of strontium originally present.

Make a standard curve of the observed P/B to the total strontium (original plus added). Determine the strontium content of the unknown samples from their measured P/B in terms of micrograms of strontium per gram of ash. Multiply this by the weight of the ash and divide by the weight of the plant material to obtain the micrograms of strontium per gram of plant material.

The sensitivity for strontium is estimated to be between 2 and 3 p.p.m., and the error is estimated to be about plus or minus 8 percent.

Sodium and Potassium

Equipment

Flame photometer—D.U. Beckman model, with photomultiplier attachment and hydrogen-oxygen burner assembly.

Reagents

(1) Sodium standard solutions: Dissolve 2.542 g. of oven-dry reagent grade sodium chloride (NaCl) in distilled water and dilute to a volume of 1 liter. This stock solution contains 1,000 p.p.m. of sodium. Dilute appropriate volumes of stock solution with distilled water to prepare a series of solutions containing 0, 1, 2.5, 5, 10, 15, 20, 30, 40, and 50 p.p.m. of sodium.

(2) Potassium standard solutions: Dissolve 1.907 g. of oven-dry reagent grade potassium chloride (KCl) in distilled water and dilute to a volume of 1 liter. This stock solution contains 1,000 p.p.m. of potassium. Dilute appropriate volumes of stock solution with distilled water to prepare a series of solutions containing 0, 1, 2.5, 5, 10, 15, 20, 30, 40, and 50 p.p.m. of potassium.

Procedure

Sodium and potassium may be estimated by using the red or blue phototube. The settings for each tube are given in table 1.

TABLE 1.—*Settings for red and blue phototubes for estimating sodium and potassium*

Item	Red phototube		Blue phototube	
	Sodium	Potassium	Sodium	Potassium
Wavelength—mμ	587	767	587	767
Slit width—mm	15	0.04	0.02	0.05
Photomultiplier setting	Off	Off	2	Full
Resistor switch position	3	3	2	2

In all cases oxygen pressure is 10 p.s.i. and hydrogen pressure is 3 p.s.i.

In the U.S. Soils Laboratory the blue phototube is used and all procedures are the same as for strontium, except the settings given here.

DETERMINATIONS ON SEPARATE SAMPLES

pH of Soil

Equipment

(1) Beaker—50 ml.
(2) pH meter.
(3) Glass stirring rod.

Procedure (8)

To a 20-g. sample of soil in a 50-ml. beaker, add 20 ml. of distilled water and stir the suspension several times at regular intervals for about an hour. Measure the pH of the soil suspension with the glass electrode, stirring well just prior to immersing the electrode deep into the suspension.

Comments

Soil-water ratios ranging from 1 : 0.5 to 1 : 10 have been proposed for the determination of the pH of soils. The pH of most soils increases with dilution, usually attaining approximately a constant value at

1:5. There is little justification for using soil-water ratios wider than 1:1. The pH measurements of soils at a moisture content below that of the moisture equivalent are subject to several inherent errors and also make mandatory the use of a special glass electrode and pH meter.

Organic Matter Content of Soil

Equipment

(1) Erlenmeyer flask—500 ml.
(2) Burets—50- and 100-ml. dispensing burets for acid.
(3) Pipet—automatic 10 ml.
(4) Asbestos.
(5) Dropping bottle.

Reagents

(1) Potassium dichromate, 1 *N*: Dissolve 49.04 g. of reagent grade potassium dichromate ($K_2Cr_2O_7$) in water and dilute to a volume of 1 liter.
(2) Sulfuric acid (H_2SO_4)—not less than 96 percent.
(3) Phosphoric acid (H_3PO_4)—85 percent, U.S.P. grade.
(4) Barium diphenylaminesulfonate indicator: Prepare a 0.16-percent aqueous solution.
(5) Ferrous sulfate, 0.5 *N*: Dissolve 140 g. of reagent grade ferrous sulfate ($FeSO_4 \cdot 7H_2O$) in water, add 40 ml. of concentrated sulfuric acid (H_2SO_4), cool, and dilute to a volume of 1 liter. Standardize this reagent each day by titrating against 10 ml. of 1 *N* potassium dichromate, as given under Procedure.

Procedure (8)

Transfer a weighed quantity of soil (ground to pass a 0.5-mm. sieve), containing 10 to 25 mg. of organic carbon into a 500-ml. Erlenmeyer flask, and add 10 ml. of 1 *N* potassium dichromate. Then add rapidly 20 ml. of concentrated sulfuric acid from the 100-ml. dispensing buret, directing the stream into the solution. Immediately swirl vigorously by hand for 1 minute and let the flask stand on a sheet of asbestos for about 30 minutes. Then add 200 ml. of water, 10 ml. of phosphoric acid from the 50-ml. dispensing buret, and 10 drops of barium diphenylaminesulfonate indicator.

Proceed with the titration as follows: Add the ferrous sulfate until the solution is purple or blue, then add the ferrous sulfate in small amounts of about 0.5 ml. until the color flashes to green with little or no warning. Add 0.5 ml. of 1 *N* potassium dichromate to restore an excess of dichromate, and complete the titration by adding ferrous sulfate drop by drop to a light-green end point. If more than 8 ml. of the available 10 ml. of potassium dichromate is reduced, the determination should be repeated with less soil.

$$\text{Percentage of organic matter in soil sample} = \frac{(\text{milliliters of 1 } N \text{ potassium dichromate (reduced)})}{(\text{grams of sample})} \times 0.69$$

Comments

The estimation of soil organic matter based on the use of the conventional empirical factor for converting organic carbon to organic matter may be subject to considerable error, even when the organic carbon is determined accurately by the more tedious dry-combustion method. For this reason, the more rapid chromic acid-titration method is now widely used. Despite its simplicity, it has been shown to give results that agree closely with those obtained by the dry-combustion method when applied to a wide variety of soils.

In this method the soil is digested with a mixture of chromic and sulfuric acids making use of the heat of dilution of sulfuric acid. Consequently, it is necessary to add the sulfuric acid rapidly and to cool the flasks uniformly on a sheet of asbestos. The unpublished results of M. Peech indicate that the volume of the potassium dichromate solution and the concentrated sulfuric acid may be reduced to half that specified in the procedure without significantly affecting the results, provided, of course, that the size of the soil sample is proportionately reduced.

The color change of the optional *o*-phenanthroline indicator occurs at a much higher oxidation-reduction potential, and this indicator is theoretically superior to diphenylamine. With certain soils, however, the color change of diphenylamine is more easily observed than that of *o*-phenanthroline; hence, both indictors are recommended. The aqueous solution of barium diphenylaminesulfonate indicator is much more stable than that prepared by dissolving diphenylamine in concentrated sulfuric acid.

Nitrates interfere only if present in quantities in excess of 5 percent of the carbon content. Carbonates, even when they constitute 50 percent of the soil, do not affect the results. Since elemental carbon, as charcoal or coal, is practically unattacked in this method, this source of error is eliminated. Interference due to significant quantities of chlorides can be overcome by adding silver sulfate to the sulfuric acid, or a correction can be made if the quantity of chlorides is known. When chlorides are present in quantities less than the molecular equivalent of carbon, 1.25 g. of silver sulfate should be dissolved in each 100 ml. of concentrated sulfuric acid.

Exchangeable Hydrogen

Equipment

(1) Erlenmeyer flasks—125 and 250 ml.

(2) Gooch-type filter funnel—15 ml., 2-cm. diameter, coarse porosity (Corning, type 36060).

(3) Filter paper—glass-fiber or conventional paper (2.1-cm. diameter).

Reagents

(1) Buffer solution: Barium chloride ($BaCl_2 \cdot 2H_2O$), 0.5 *N*, and triethanolamine, 0.2 *N*: Dilute 100 ml. of commercial triethanolamine (specific gravity 1.126, about 8 *N*) with 1,000 ml. of distilled water and partially neutralize with hydrochloric acid (HCl) to

adjust to pH 8.1–8.2 (this requires approximately 360 ml. of 1 *N* hydrochloric acid). Make up to a volume of 2 liters with water and mix with 2 liters of a solution containing 250 g. of barium chloride. Protect from the carbon dioxide of the air.

(2) Replacement solution: Barium chloride: Dissolve 250 g. of barium chloride in 4 liters of distilled water, add 10 ml. of buffer solution, and mix.

(3) Sodium hydroxide, 0.01 *N*: This solution need only be approximate. Weigh 0.4 g. of sodium hydroxide (NaOH) and dissolve in 1 liter of distilled water.

(4) Bromcresol green, 0.04 percent: Triturate 0.1 g. of the indicator with 14.3 ml. of 0.01 *N* sodium hydroxide and dilute the mixture to a volume of 250 ml. with distilled water.

(5) Methyl red, 0.02 percent: Triturate 0.04 g. of the indicator with 1.5 ml. of 0.01 *N* sodium hydroxide and dilute to a volume of 200 ml. with distilled water.

(6) Standard hydrochloric acid, 0.10 *N*: Dilute 8.35 ml. of concentrated hydrochloric acid to a volume of 1 liter with distilled water. Standardize this solution against a standard base by accepted procedures.

Procedure (8)

Place 10 g. of soil in a 125-ml. Erlenmeyer flask, add 25 ml. of buffer solution, and allow the flask to stand for one-half hour, mixing the contents occasionally by swirling. Transfer to a Gooch-type filter funnel containing a moist filter paper disk and filter into a 250-ml. Erlenmeyer flask. Use an additional 25 ml. of buffer solution to aid in the transfer of all the soil to the funnel. Leach the soil with 100 ml. of the replacement solution by adding small increments. This filtration and leaching should not be completed in less than 30 minutes.

To the leachate, add 10 drops of bromcresol green and 2 drops of methyl red. Titrate with 0.10 *N* hydrochloric acid. The end point can be chosen as any point during the progressive color change from a bluish green through violet to pink. This end point should be checked against a blank containing 50 ml. of buffer solution and 100 ml. of replacement solution and titrated to the same end point with the 0.10 *N* hydrochloric acid. This end point should be reached when titrating the soil extracts. All calculations are made with this blank determination as a reference.

Available and Fixed Strontium 90 in Soils

Equipment

(1) Erlenmeyer flask—2 liters.
(2) Büchner funnels (6- and 8-inch diameter).
(3) Filter paper—Whatman No. 42 or equivalent.
(4) Suction flasks—1 and 2 liters.
(5) Beakers—150 and 800 ml., 2 and 3 liters.
(6) Hotplate.
(7) Funnel—long stem (9-cm. diameter).

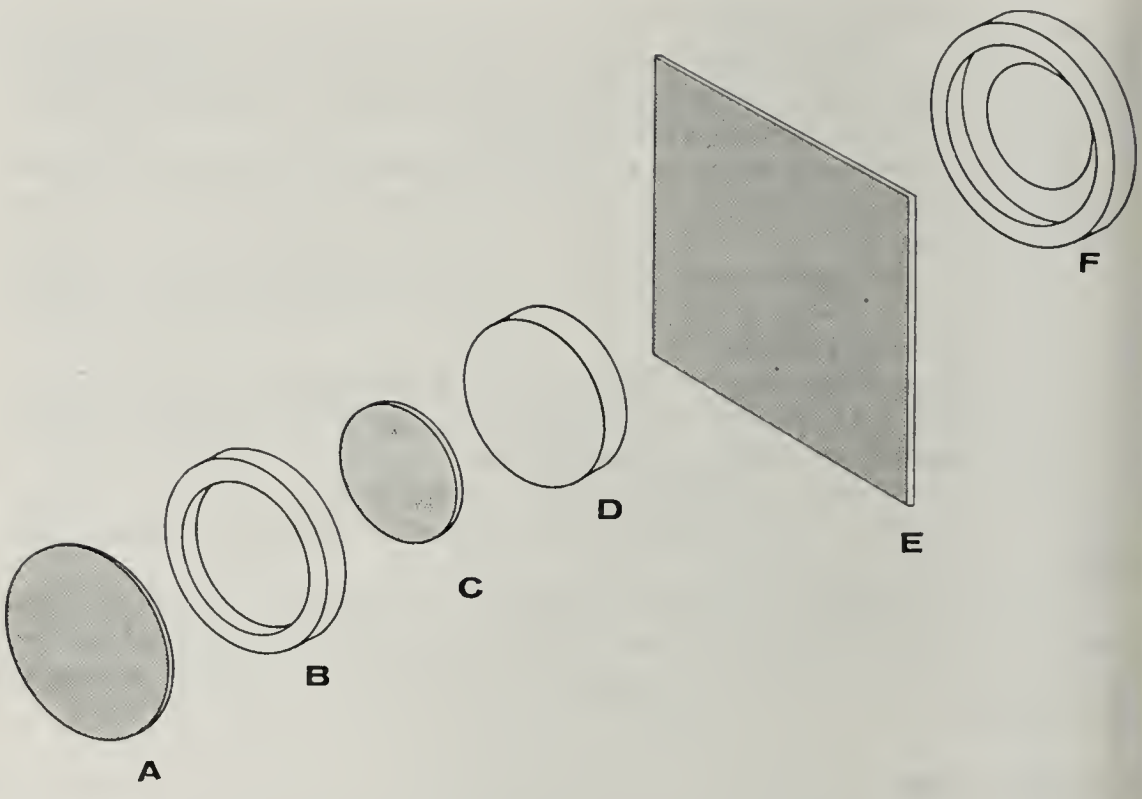

FIGURE 1.—Assembly of sample holder.

(8) Platinum evaporating dish—50 ml.
(9) Electric muffle furnace, with automatic temperature control.
(10) Mortar and pestle.
(11) Glass stirring rod.
(12) Indicator paper.
(13) pH meter.
(14) Ice bath—crushed ice in water.
(15) Mechanical stirrer.
(16) Glass wash bottle.
(17) Fritted glass filter assembly (see equipment for Strontium by Flame Photometry).
(18) Glass-fiber filter pad—2.1 cm.
(19) Sample holder (see fig. 1): Machine an aluminum disk 38 mm. in diameter and 4 mm. thick so that it has a 3-mm. well (wall thickness 3 mm.) and a hole in the center of the well 23 mm. in diameter (F). Make an aluminum ring (B) approximately 32-mm. outer diameter, 29-mm. inner diameter, and 3 mm. high so that it fits loosely in the well. Use a steel disk (D) 28 mm. in diameter and 3 mm. thick as backing for the sample. Assemble the parts as follows: Glue the Saran film (A) to the aluminum ring (B). Center the 2.1-cm. glass-fiber filter pad (C), on which the sample has been collected, on the steel disk (D). Place the aluminum ring (B) over the steel disk (D) so that the Saran film holds and protects the sample. Invert the ring (B) and the disk (D) and cover with the Saran film (E). Place the well of the machined aluminum disk (F) over the Saran film (E) and press down so that all other parts fit into the well. Trim any excess Saran film (E) with a sharp knife. The exact size of the sample holder may be varied to fit the automatic sample-changing equipment. The sample is then ready to count.
(20) Low-background G.M. counting equipment.

Reagents

(1) Strontium nitrate, 2 *N*: Dissolve 3,810 g. of strontium nitrate ($Sr(NO_3)_2$) in distilled water and dilute to a volume of 18 liters with distilled water.

(2) Hydrochloric acid: For 6, 2, 1, and 0.2 *N*, dilute 9 and 3 liters and 1,500 and 42 ml., respectively, of concentrated hydrochloric acid (HCl), each one to a volume of 18 liters with distilled water.

(3) Nitric acid (HNO_3)—concentrated, reagent grade.

(4) Yttrium carrier: Dissolve 4 g. of yttrium oxide (Y_2O_3) in 5 ml. of concentrated nitric acid. After the reaction is complete, dilute to a volume of 200 ml. Check the radioactive purity of this reagent. Add 1 ml. of reagent solution to 200 ml. of distilled water, add 5 ml. of concentrated nitric acid, allow to stand for 14 days, and milk as given under Procedure. If contaminated, the yttrium nitrate solution can be purified by following the procedures used in the Health and Safety Laboratory (*6*).

(5) Sulfuric acid (H_2SO_4)—concentrated, reagent grade.

(6) Sodium carbonate (Na_2CO_3)—reagent grade.

(7) Ammonium hydroxide, 4 *N*: Dilute 670 ml. of concentrated ammonium hydroxide (NH_4OH) to a volume of 2,500 ml. with distilled water. Ammonium hydroxide, 1 percent: Dilute 180 ml. of concentrated ammonium hydroxide to a volume of 18 liters with distilled water.

(8) Acetic acid, glacial (HOAc).

(9) Sodium dichromate, 1 *M*: Dissolve 298 g. of sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$) in water and dilute to a volume of 1 liter.

(10) Barium chloride, 0.5 *M*: Dissolve 61 g. of barium chloride ($BaCl_2 \cdot 2H_2O$) in water and dilute to a volume of 500 ml.

(11) Potassium cyanate (KCNO)—reagent grade.

(12) Ammonium oxalate: Add approximately 50 g. of ammonium oxalate ($(NH_4)_2C_2O_4 \cdot H_2O$) to 1 liter of water. An excess of salt should remain on the bottom after equilibrium is obtained by frequent shaking.

(13) Ethyl alcohol (C_2H_5OH)—95 percent.

(14) Standard strontium 90: Radioactive solution standard type RS 90 obtained from Nuclear Chicago Corporation, Standards Section.

(15) Potassium chloride (KCl)—reagent grade.

Procedure

Extraction of Soil.—Place 1 kg. of soil in a 2-liter Erlenmeyer flask with 1 liter of strontium nitrate solution. The concentration of strontium nitrate is adjusted so that 3 liters of it contains strontium equivalent to 10 times the total exchangeable cations of the soil, which were previously determined by the ammonium acetate method for bases and the barium chloride-triethanolamine method for hydrogen (p. 16). The strontium nitrate solution is easily made up for each sample from a stock solution of 2 *N* strontium nitrate. Stir the soil and solution well and allow to stand overnight. Filter through an 8-inch Büchner funnel, using Whatman No. 42 paper, into a 2-liter suction flask. After the soil has drained, resuspend it in 1 liter of the strontium nitrate solution for that soil, and filter again after 2 to 6 hours. This time the filtration will be much slower, and the sample may be divided about equally between two Büchner funnels. Wash the soil

with the third 1-liter part of the strontium nitrate solution. Combine the extracts in a 3-liter beaker and evaporate to dryness on a hotplate. These extracts contain the available fraction of the strontium 90.

Place the extracted soil in a 3-liter beaker and add 1.5 liters of 6 *N* hydrochloric acid. Stir well and allow to stand for 5 days on a hotplate at 70° to 80° C. Filter through an 8-inch Büchner funnel, washing with 1 liter of 1 *N* hydrochloric acid. Combine the extracts in a 3-liter beaker and evaporate to dryness on a hotplate. This material contains the fixed fraction of strontium 90. Discard the extracted soil.

Treatment of Extracts.—The small amount of organic matter in the strontium nitrate extract can be destroyed easily by adding 100 ml. of concentrated hydrochloric acid and evaporating to dryness. Dissolve the sample in 500 ml. of water containing 5 ml. of concentrated nitric acid and filter through Whatman No. 42 paper into an 800-ml. beaker. Add 1 ml. of yttrium nitrate solution containing 20 mg. of yttrium. The sample is now ready for removal of natural radioactive contaminants.

If the soil sample contained approximately 200 meq. or greater of calcium and magnesium, the strontium nitrate extract will need to be carried through the strontium sulfate precipitation procedure as described below for the hydrochloric acid extract. The large amount of strontium present will require splitting the sample to attain complete strontium precipitation. To check this, more sulfuric acid may be added to the filtrate to see if additional strontium sulfate forms. The strontium sulfate from all subsamples is combined for the fusing process.

The hydrochloric acid extract contains large quantities of aluminum, iron, silicon, and organic matter, as well as the desired strontium, and requires the following treatment: Add 100 ml. of concentrated nitric acid. After the reaction has subsided, begin heating gently to avoid loss of the foaming sample. Evaporate the solution to dryness. Dissolve the precipitate in 200 ml. of 6 *N* hydrochloric acid, heating as necessary. Dilute with 400 ml. of water and filter through a 6-inch Büchner funnel into a 1-liter suction flask. Transfer the filtrate into a 2-liter beaker and add 50 ml. of concentrated sulfuric acid to precipitate the strontium sulfate. Digest the precipitate on the hotplate for several hours, and filter through a long-stem funnel with Whatman No. 42 filter paper.

Transfer the paper and precipitate to a platinum evaporating dish and burn off the filter paper in a muffle furnace with the door open and temperature about 200° C. After the filter paper is charred, close the door and increase the temperature to 500° for 1 hour. Weigh the strontium sulfate and mix thoroughly with an equal weight of sodium carbonate, using a mortar and pestle. Place the mixture in a platinum evaporating dish and fuse it in a muffle furnace at 900°. After 1 hour at this temperature, turn off the furnace and allow the dish to cool inside the furnace. The cake then comes easily out of the dish. Place it in a 800-ml. beaker with 400 ml. of water, heat gently, and break up the cake with a glass stirring rod. When the cake is completely broken up, an undissolved residue of strontium carbonate remains. Filter through Whatman No. 42 filter paper in a 9-cm. funnel. Dissolve the strontium carbonate in 200 ml. of 2 *N* hydro-

chloric acid, and remove the small undissolved residue by filtration through Whatman No. 42 paper in a 9-cm. funnel. Add 1 ml. of yttrium nitrate solution containing 20 mg. of yttrium.

Removal of Natural Radioactive Contaminants.—Some soils contain radioactive contaminants that interfere with the determination of strontium 90, particularly in the hydrochloric acid extract. These are principally daughters of radium 226 and thorium 232. Scavenges with yttrium hydroxide and barium chromate remove most of the contaminants. The barium chromate scavenge is done by the method of homogeneous precipitation (*5*).

Heat the extracts and precipitate yttrium hydroxide by adding 4 *N* ammonium hydroxide to pH 8, using either indicator paper or a pH meter to check the pH. Digest the samples for 1 hour after the precipitate is formed. The precipitate often contains noticeable quantities of manganese oxide, ferric hydroxide, and aluminum hydroxide. Filter through Whatman No. 42 paper in a 9-cm. long-stem funnel, maintaining a column of liquid in the funnel stem to speed the filtration.

For the barium chromate scavenge, acidify the filtrate with 5 ml. of concentrated nitric acid and add 1 ml. of acetic acid, 1 ml. of 1 *M* sodium dichromate, and 2 ml. of 0.5 *M* barium chloride. Adjust the pH of the extracts to 2.0–2.5 by adding ammonium hydroxide. Cool the extracts in an ice bath while using a mechanical stirrer. Stir 3 g. of potassium cyanate, dissolved in a little water, into the extract. After 3 to 6 hours of continuous stirring and when the pH of the extract has risen to 5.0–5.2, filter through Whatman No. 42 paper and discard the precipitate. It is necessary to repeat the barium chromate scavenge at least once. Add 5 ml. of concentrated nitric acid, 1 ml. of 1 *M* sodium dichromate, 2 ml. of 0.5 *M* barium chloride, adjust the pH to 2.0–2.5, and proceed as for the first barium chromate scavenge. Add 5 ml. of concentrated nitric acid and 1 ml. of yttrium nitrate solution to the extracts and heat to remove the dissolved carbon dioxide. Proceed with the final yttrium hydroxide scavenge, as indicated in the preceding paragraph. Put aside the extracts for buildup and milking of yttrium 90.

Milking of Yttrium 90.—The yttrium 90 radioactive daughter of strontium 90 is easily separated from the large amount of strontium in the two extracts. Since yttrium 90 has a half-life of 64.6 hours, it reaches 97 percent of its equilibrium value with strontium 90 in 2 weeks after any separation. Thus, milkings can be made repeatedly. Each time the extracts are put aside for buildup of yttrium 90, they are acidified with concentrated nitric acid and 20 mg. of yttrium is added.

Heat the sample and precipitate yttrium hydroxide as for the yttrium hydroxide scavenge. After digestion and filtration, dissolve the yttrium hydroxide in a minimum quantity of hot 0.2 *N* hydrochloric acid, which is directed on the precipitate as a stream from a wash bottle. Collect the yttrium chloride solution in a 150-ml. beaker. Heat, add 5 ml. of saturated ammonium oxalate solution, and adjust the pH to 6.0. Allow the precipitated yttrium oxalate to digest about 1 hour. Then filter through a small fritted glass funnel, catching the precipitate on a 2.1-cm. glass-fiber filter pad. Dry the precipitate by washing with 95-percent ethyl alcohol. Transfer it to a sample holder (fig. 1) for the radioactivity determination.

The radioactivity determination is made with an end window G.M. tube. Use anticoincidence circuit and shielding to obtain background counts of 1.5 to 2.0 c.p.m.

Count the sample four times over a 2-week period. Two of these counts should be within the first 3 days after the yttrium hydroxide precipitation. Make the third count approximately 5 days after the precipitation and the final count after 10 days.

For each count a standard deviation is calculated according to the following equation:

$$\text{Standard deviation} = \frac{\sqrt{N_{\text{bkg.}} + N_{\text{sample}}}}{t}$$

Where $N_{\text{bkg.}}$ = total count of background in time (t)

N_{sample} = total count of sample in time (t)

The count per minute plus or minus its standard deviation is plotted against the theoretical fraction of yttrium 90 left. This fraction is determined from its radioactive decay constant. For example, one-half is left 65 hours after precipitation of yttrium hydroxide and one-fourth is left 130 hours after precipitation. The time interval for radioactive decay is taken as the midpoint of each of the four counting periods. If the sample is uncontaminated, a straight line will result, which intercepts the abscissa at zero, showing no yttrium 90 left. The extrapolated line to the ordinate becomes the disintegrations per minute of strontium 90 per original soil sample when the appropriate efficiency factor is used.

The efficiency factor is obtained by taking a solution containing a known amount of strontium 90 through the entire procedure. This factor should be rechecked every 2 months. Potassium chloride is used as a working standard. The weight of potassium chloride used is estimated from the count rate of the samples being analyzed. One gram of potassium is equivalent to 1,776 disintegrations per minute. The potassium chloride standard and background counts should be made every 2 days.

Strontium 90 in Plants

The strontium 90 determination for plant material is basically the same as described in the preceding section for soils. Strontium 90 is brought into solution, interfering ions are eliminated, and yttrium 90 is separated. The amount of plant material used will vary according to its strontium 90 content. With low-background counting equipment, 1 picocurie is about the minimum that can be determined accurately. Ten or more picocuries are desirable for a quicker and more accurate determination.

Several hundred grams of plant material are generally used to obtain high enough count rates for a convenient radioactivity determination. Thus, other ions may be sufficiently concentrated so as to cause interference with the chemical procedure. Phosphate and sulfate may interfere, but they can easily be removed by following the strontium

sulfate precipitation procedures given in the preceding section pertaining to the treatment of the hydrochloric acid (HCl) extract of soil. Calcium may interfere in the filtration of the strontium sulfate. In this case the supernate is decanted, while still hot, from the strontium sulfate precipitate. The supernate is filtered quickly and the material on the filter paper is recombined with the strontium sulfate.

The plant material may be contaminated with fresh fission products, which could interfere in the yttrium 90 radioactivity measurement. The interfering fission products can be eliminated by following the yttrium hydroxide and barium oxalate scavenge procedures described in the preceding section. The yttrium 90 milking procedure and radioactivity measurement are performed as given in the preceding section.

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CONTENTS

Introduction ---- 1
History of rice in the United States ---- 1
Distribution of rice in the United States ---- 3
Acreage, yield, and production of rice in the United States ---- 3
Selected references ---- 4
Distribution and origin of species, botany, and genetics ---- 5
Distribution of the species of *Oryza* and origin of cultivated rice ---- 5
Description and development of the rice plant and classification of cultivated varieties ---- 6
Description of plant ---- 7
Development of plant ---- 8
Classification of varieties ---- 9
Genetics ---- 9
Selected references ---- 16
Rice breeding and testing methods in the United States ---- 19
History and objectives ---- 19
Cultural methods and equipment for breeding rice in the United States ---- 20
Breeding methods ---- 24
Introduction ---- 24
Selection ---- 25
Hybridization ---- 25
Irradiation ---- 28
Breeding for agronomic characters ---- 28
Testing for milling, cooking, and processing qualities ---- 33
Milling quality ---- 33
Cooking and processing qualities ---- 35
Breeding for disease resistance ---- 38
Blast ---- 39
Brown leaf spot ---- 39
Narrow brown leaf spot ---- 40
Straighthead ---- 40
White tip ---- 40
Hoja blanca ---- 40
Description of varieties ---- 42
Short-grain varieties ---- 42
Medium-grain varieties ---- 44
Long-grain varieties ---- 45
Other kinds of rice ---- 47
Performance of varieties ---- 47
Choosing the variety ---- 49
Varietal response to seeding date ---- 51
Results of tests with older varieties ---- 51
Results of tests with newer varieties and selections ---- 52
Production of seed rice ---- 56
Origin of high-quality seed rice ---- 56
Classes of seed in a certification program ---- 56
Cleaning, grading, and processing seed rice 59
Standards for seed certification ---- 61
Selected references ---- 62
Soils and fertilizers ---- 65
Types of soils used for rice production ---- 65
Arkansas ---- 65
Louisiana ---- 65
Texas ---- 65
California ---- 65
Chemistry of flooded soils ---- 67
Fertilizers ---- 69
Southern rice area ---- 69
California ---- 71
Selected references ---- 72
Culture ---- 74
Rotation or cropping systems ---- 74
Arkansas ---- 75
Louisiana ---- 76
Mississippi ---- 77
Missouri ---- 78
Texas ---- 78
California ---- 79
Land leveling and seedbed preparation ---- 79
Land grading and leveling ---- 79
Seedbed preparation ---- 81
Seedbed preparation as related to method of seeding ---- 82
Construction of levees ---- 83
Seed and seeding ---- 84
Seed quality ---- 84
Source of seed ---- 85
Seed treatment ---- 85
Time of seeding ---- 86
Rate of seeding ---- 87
Method of seeding ---- 88
Transplanting rice ---- 91
Irrigating and draining ---- 91
Amount of water required ---- 92
Source of water ---- 92
Quality of water ---- 93
Water temperature and oxygen content ---- 94
Water control methods ---- 95
Water management ---- 97
Draining for harvest ---- 99
Harvesting, drying, and storing ---- 99
Harvesting ---- 99
Drying and storing ---- 103
Selected references ---- 106
Weeds and their control ---- 111
Rice diseases ---- 113
Major diseases ---- 113
Blast ---- 113
Brown leaf spot ---- 114
Narrow brown leaf spot ---- 114
Root rot ---- 115
Seedling blight ---- 116
Stem rot ---- 116
Straighthead ---- 117
White tip ---- 117
Minor diseases ---- 118
Bordered sheath spot ---- 118
Hoja blanca ---- 118
Kernel smut ---- 119
Kernel spots ---- 119
Leaf smut ---- 119
Selected references ---- 120
Insects and their control ---- 121
Rice water weevil ---- 121
Rice stink bug ---- 121
Grape colaspis ---- 122
Other pests of rice ---- 122
Selected references ---- 124

RICE IN THE UNITED STATES: VARIETIES AND PRODUCTION

INTRODUCTION

By C. Roy Adair

Rice, a leading cereal crop in many countries, is grown on all continents. It often is considered to be a tropical crop, although it is grown in both the temperate and the tropical zones in Africa, Asia, North America, Oceania, and South America, and in the southern part of Europe. About 93 percent of the world rice crop was produced in Asia during the 5-year period ending in 1960 (table 1). Only slightly more than 1 percent was produced in the United States during this period. The United States is, however, the leading rice-producing country in North America and is second to Brazil in the Western Hemisphere. Other leading rice-producing countries, outside of Asia and adjacent islands, are United Arab Republic (Egypt) and Malagasy Republic (Madagascar) in Africa, and Italy and Spain in Europe.

Rice yields vary widely among the rice-producing countries (table 1). Yields generally are much higher in temperate than in tropical zones, not only because of differences in climate but also because of differences in cultural practices and in varieties grown.

Table 1.—*Rice acreage, production, and yield per acre for each continent and selected countries, averages for 5-year period, 1956–60*

Continent and country	Acreage	Production	Yield
	1,000 acres	*Million pounds*	*Pounds per acre*
Asia	258,000.4	427,330.2	1,656
India	81,353.2	99,106.7	1,218
Japan	8,050.2	32,845.4	4,081
South America	8,091.6	12,496.2	1,544
Brazil	6,615.0	9,539.7	1,442
Peru	166.4	574.4	3,452
Africa	7,808.0	9,686.0	1,240
Congo	400.0	392.6	982
United Arab Republic (Egypt)	695.4	2,832.4	4,073
North America	2,825.0	6,985.3	2,473
Mexico	315.6	582.0	1,844
United States	1,501.8	4,946.2	3,294
Europe	860.6	3,434.8	3,991
Italy	325.6	1,440.3	4,423
Spain	157.6	841.7	5,341
Oceania	117.2	330.9	2,823
Australia	50.2	240.7	4,795
World total	277,702.8	460,263.4	1,657

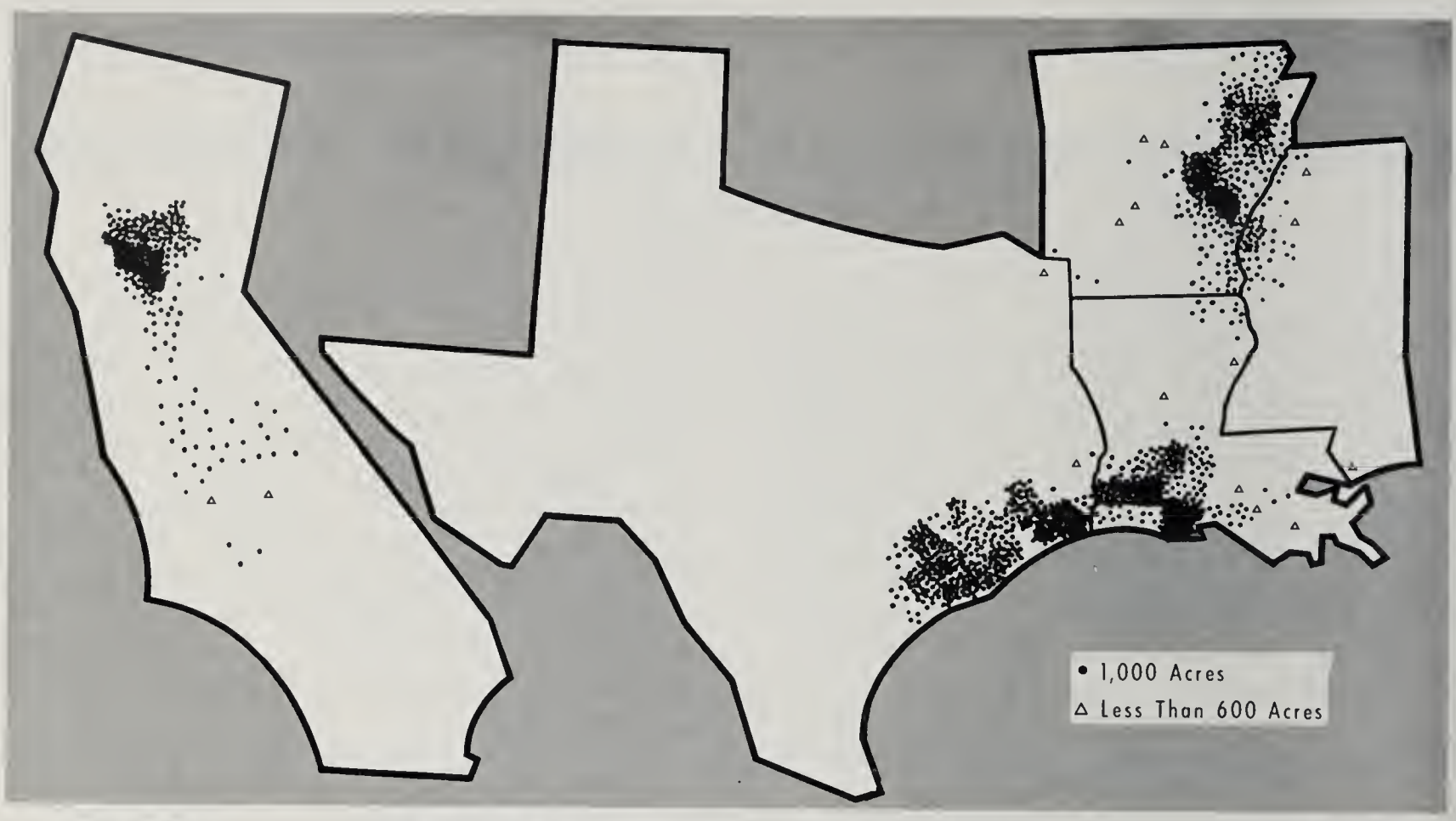
Source: U.S. Department of Agriculture, Agricultural Statistics: 1958, p. 21; 1959, p. 22; 1960, p. 22; 1961, p. 22.

History of Rice in the United States

Rice has been grown in the United States since the latter part of the 17th century (*2*).[1] Trial plantings of rice were made in Virginia as early as 1609 (*4*). Apparently other plantings were made in the colonies along the South Atlantic coast from that time on, and ricegrowing was firmly established in South Carolina about 1690.

Until about 1890, rice in the United States was grown principally in the Southeastern States, although some was grown along rivers in the South Central States. Experimental plantings were made in the prairie section of southwest Louisiana from 1884 to 1886 (*7*), and rice culture became established in that area about 1888. Production then increased rapidly in that part of Louisiana, and in the adjacent part of Texas. Some rice was grown along rivers in Arkansas in early years, but it did not become an important cash crop in the State until after 1904 (*9*), when ricegrowing was started in Grand Prairie. Experimental plantings were made near Butte Creek in the Sacramento Valley in California in 1909 (*3*), and rice became established as a commercial crop in that area about 1912. Rice production has been of considerable importance in the delta area of Mississippi since about 1948 (*2*).

[1] Italic numbers in parentheses refer to Selected References, p. 4.



ARKANSAS

SECTION AND COUNTY	ACRES
NORTHEAST	
Clay	7,770
Craighead	16,935
Crittenden	6,439
Crass	34,060
Faulkner	318
Greene	5,406
Independence	852
Jacksan	20,200
Lawrence	8,251
Mississippi	1,505
Painsett	38,400
Randalph	2,100
St. Francis	17,840
White	1,140
Waadruff	19,760
CENTRAL	
Arkansas	76,150
Clark	400
Canway	114
Hat Spring	470
Jeffersan	17,046
Lee	8,395
Lanoke	39,000
Manrae	14,000
Perry	981
Phillips	5,068
Prairie	39,570
Pulaski	1,855
SOUTHEAST	
Ashley	6,429
Chicat	9,603
Desha	14,000
Drew	4,594
Lincaln	9,410

ARKANSAS CONT.

SOUTHWEST	
Lafayette, Little River, Miller	2,000
TOTAL ACRES ARKANSAS 1963	430,061

TEXAS

SECTION AND COUNTY	ACRES
EAST	
Bawie	559
Chambers	43,503
Hardin	1,004
Jasper	86
Jeffersan	62,294
Liberty	37,540
Newtan	731
Orange	4,972
CENTRAL	
Brazaria	54,003
Ft. Bend	19,203
Galvestan	12,143
Harris	34,889
Waller	15,038
WEST	
Austin	2,865
Calhaun	4,287
Calarada	35,599
Jacksan	27,153
Lavaca	6,194
Matagarda	44,846
Victaria	5,083
Whartan	52,740
TOTAL ACRES TEXAS 1963	464,732

CALIFORNIA

SECTION AND COUNTY	ACRES
SACRAMENTO VALLEY	
Butte	55,202
Calusa	74,125
Glenn	40,846
Placer	3,050
Sacramenta	10,126
Sutter	57,789
Yala	25,062
Yuba	12,549
SAN JOAQUIN VALLEY	
Fresna	20,818
Kern	3,435
Kings	197
Madera	2,745
Merced	7,429
San Jaaquin	7,453
Stanislaus	2,260
Tulare	544
TOTAL ACRES CALIFORNIA 1963	323,630

MISSISSIPPI

COUNTY	ACRES
Balivar	21,400
Caahama	1,664
De Sata	1,639
Hancack	184
Humphreys	1,935
Leflare	3,874
Quitman	1,408
Sharkey	1,150
Sunflawer	4,300
Tallahatche	510
Tate	246
Tunica	2,895
Washingtan	9,427
TOTAL ACRES MISSISSIPPI 1963	50,632

LOUISIANA

SECTION AND PARISH	ACRES
NORTH	
East Carrall	5,267
Grant	185
Madisan	896
Marehause	5,949
West Carrall	1,185
RIVER	
Ascensian	1,316
Assumptian	196
Iberville	323
Lafaurche	54
St. James	1,472
St. Jahn	1,436
Tensas	126
TECHE	
Avayelles	2,770
Iberia	6,500
Lafayette	9,530
Rapides	574
St. Martin	4,060
St. Mary	3,100
SOUTHWEST	
Acadia	93,500
Allen	24,000
Beauregard	4,943
Calcasieu	65,088
Cameran	13,337
Evangeline	39,640
Jeffersan Davis	95,692
St. Landry	16,945
Vermillian	114,800
TOTAL ACRES LOUISIANA 1963	512,884

FIGURE 1.—Distribution of the United States rice acreage in the principal producing States.

Distribution of Rice in the United States

Although rice is probably the leading food crop of the world, it is a major crop in the United States in certain areas only. Rice production in the United States is centered in the Southern States of Arkansas, Louisiana, Mississippi, and Texas and in California. It is the principal cash crop in many counties and parishes (fig. 1). Small amounts of rice also are grown in Missouri, Oklahoma, South Carolina, and Tennessee. Some rice has been grown in each of the States in Southeastern United States.

In the United States, satisfactory rice crops require (1) high temperature, especially relatively high mean temperatures during the growing season; (2) a dependable supply of fresh water for irrigation; (3) a terrain that is level enough to permit flood irrigation but that slopes enough so that surface water can be readily drained; and (4) soil that will hold water well because of its fine texture, or a subsoil through which loss by seepage is small (*6*). These climatic and soil conditions prevail in the areas where rice is grown in the United States.

Rainfall and humidity during the growing season are comparatively high in the Southern States, so less irrigation water is required there than in California (*1*). Irrigation water is supplied from streams, from reservoirs where water is impounded in winter and early spring, and from wells. To produce optimum yields, proper cultural practices must be followed. These practices include preparing a suitable seedbed, maintaining a uniform depth of irrigation water, providing sufficient soil nutrients for optimum growth, and controlling insects and diseases and weeds and grasses. Good-quality seed of adapted varieties must be used to maintain quality and to produce high economical yields. For safe storage, the rice must be harvested at the right stage and dried to the proper moisture level.

Acreage, Yield, and Production of Rice in the United States

In the 5-year period ending in 1963, Arkansas produced 24.89 percent of the total United States rice crop; Louisiana, 24.26 percent; California, 24.12 percent; Texas, 23.99 percent; Mississippi, 2.47 percent; and Missouri, 0.26 percent (*8*). The United States has been self-sufficient in rice production since 1917, and now is one of the leading rice-exporting countries of the world.

Rice acreage in the United States (fig. 2) increased from a 5-year annual moving average of 301,000 acres in 1899 to 1,105,000 acres in 1922. It then declined until 1936. The 5-year annual moving average acreage increased each year until 1955, when it was 2,106,000. The peak acreage of 2,550,000 was reached in 1954. The annual acreage then declined until 1957, when it was 1,340,000. Starting in 1958, acreage increased slightly each year until 1963, when it was 1,765,000.

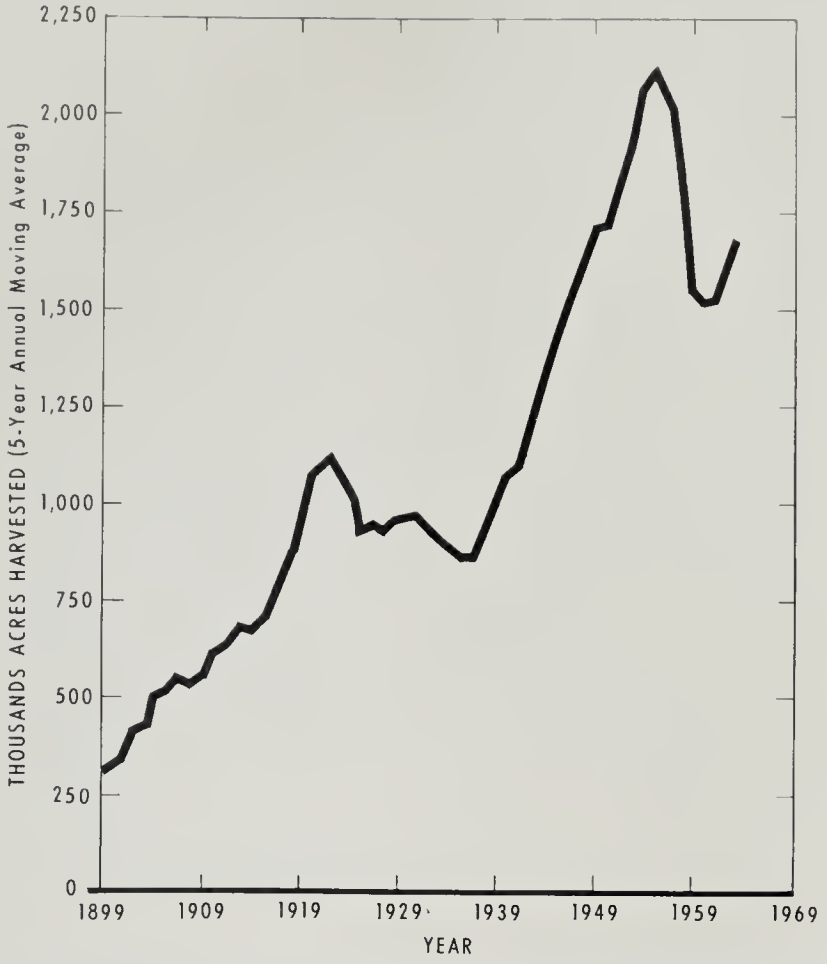


FIGURE 2.—Harvested acreage of rice in the United States (5-year annual moving average), 1899–1963.

Yield per acre (fig. 3) in the United States increased from a 5-year annual moving average of 1,091 pounds per acre in 1899 to 3,563 pounds per acre in 1963. This gradual increase in yield per acre has been brought about by improved cultural practices, such as better rotations, weed control, and irrigation and fertilization practices; better machinery, which led to improved and more timely field operations; better methods of controlling diseases and insects; and improved varieties. Average yields have fluctuated from year to year, with a long-term upward trend. However, there have been short periods when average yields declined. The 5-year annual moving average yield per acre increased gradually from 1899 to 1940, but six times during this period the 5-year average yield was lower than that of the previous year. Yields declined from 1941 to 1945. Labor and equipment were scarce during the war years, and the acreage was expanded to include some

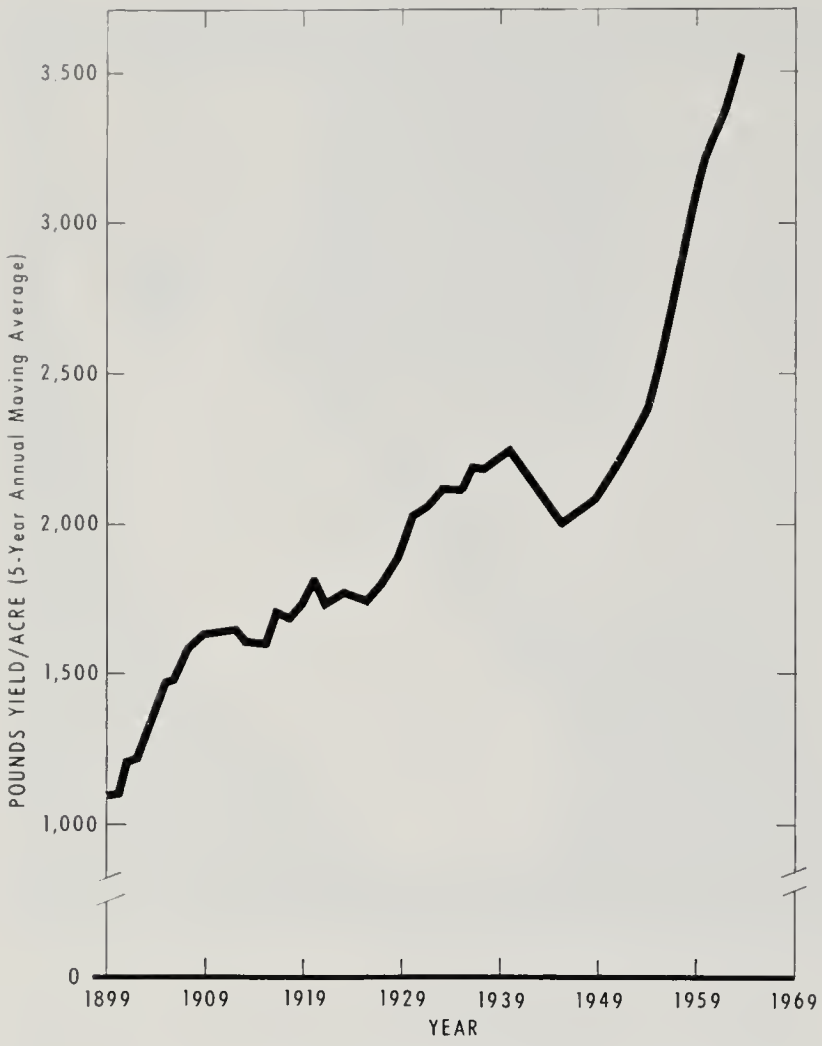


FIGURE 3.—Yield per acre of rice in the United States (5-year annual moving average), 1899–1963.

fields with poor soil. These factors may have accounted for the lower yields in this period. The 5-year average yield per acre increased each year from 1946 through 1963. Higher rates of fertilizer application and other improved cultural practices increased yields during this period.

Production of rice (100-pound bags) in the United States in 1718 was estimated to be over 79,000 bags of rough rice (*5*). Production increased to nearly 3.5 million bags in 1849. It then declined to about 637,000 bags by 1871. By 1899, production had increased to 3.4 million bags.

The 5-year annual production increased to 19.4 million bags in 1922. Production declined until 1926 and then increased slightly. However, it remained within the range of 14 to 20 million bags until 1936. The annual production fluctuated from year to year but with an upward trend during the period from 1937 to 1954 when production reached a high of 64.2 million bags. Annual production declined until 1958 and then increased each year until 1963 when the annual production was 69.3 million bags, and the 5-year annual moving average was 59.3 million bags (fig. 4).

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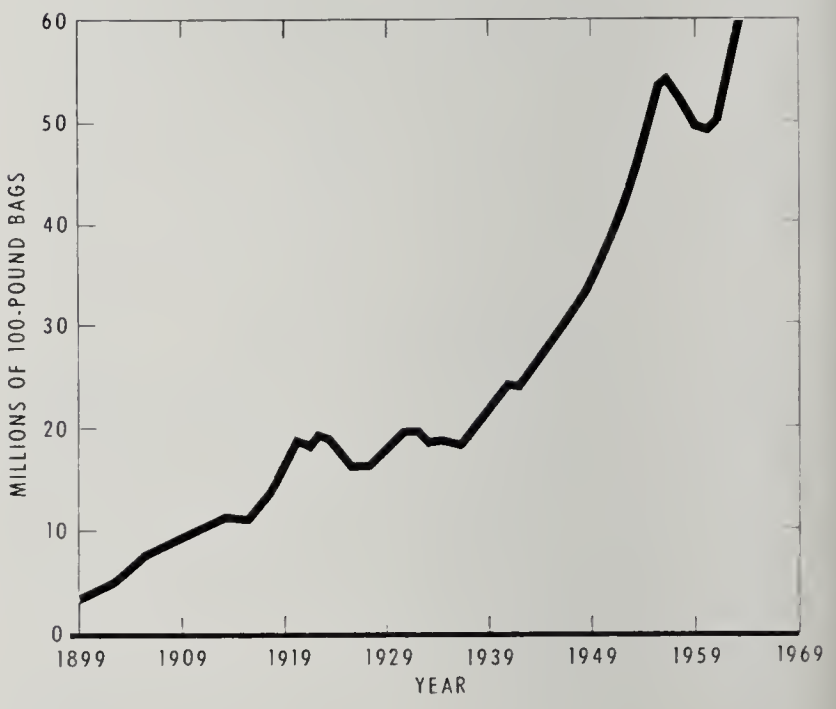

FIGURE 4.—Production of rice in the United States (5-year annual moving average), 1899–1963.

DISTRIBUTION AND ORIGIN OF SPECIES, BOTANY, AND GENETICS

By C. Roy Adair and Nelson E. Jodon

Distribution of the Species of *Oryza* and Origin of Cultivated Rice

Species of *Oryza* have been reported from all continents except Europe and from many of the larger islands. Roschevicz (*53*) [1] reported a comprehensive study of the genus, and he concluded from his study that there were 20 species of *Oryza*. Chevalier (*15*) reported a similar study in which he recognized 22 species. Chatterjee (*13*) later summarized the information on *Oryza* and listed 23 species. Tateoka (*64*) summarized the information on species of *Oryza* in 1963 and recognized 22 valid species. The 18 species that were recognized by both Chatterjee (*13*) and Tateoka (*64*) are listed in table 2.

Five species were recognized by Chatterjee (*13*) but not by Tateoka (*64*) so they were not listed in table 2. These are *O. granulata* Nees & Arn. ex Hook. f.; *O. perennis* Moench; *O. sativa* L. var. *fatua* Prain; *O. stapfii* Roschev.; and *O. subulata* Nees. Four species were recognized by Tateoka (*64*) but not by Chatterjee (*13*) so they were not listed in table 2. These are *O. angustifolia* Hubbard; *O. barthii* A. Cheval.; *O. longiglumis* Jansen; and *O. rufipogen* Griff. The chromosome number of the species of *Oryza* as reported by Kihara (*35*) and the distribution as reported by Chatterjee (*14*) also are shown in table 2.

Table 2.—*Species, chromosome number, and distribution of* Oryza

Species	Chromosome No. (2n)	Distribution
1. *O. alta* Swallen	24 and 48	South America and Central America.
2. *O. australiensis* Domin	24	Australia.
3. *O. brachyantha* A. Cheval. & Roehr.	24	West Tropical Africa and Central Africa.
4. *O. breviligulata* A. Cheval. & Roehr.	24	West Tropical Africa.
5. *O. coarctata* Roxb.	48	India and Burma.
6. *O. eichingeri* Peter	48	East Africa.
7. *O. glaberrima* Steud.	24	West Tropical Africa and Central America.[1]
8. *O. grandiglumis* (Doell) Prodoehl	24 and 48	South America.
9. *O. latifolia* Desv.	48	Central America, South America, and West Indies.
10. *O. meyeriana* (Zoll. & Mor.) Baill.	24	Java, Borneo, Philippines, and Siam.
11. *O. minuta* Presl	48	Malay Peninsula, Philippines, Sumatra, Java, and Borneo.
12. *O. officinalis* Wall. ex Watt	24	India and Burma.
13. *O. perrieri* A. Camus	----------	Madagascar.
14. *O. punctata* Kotschy ex Steud.	----------	Northeast Tropical Africa.
15. *O. ridleyi* Hook. f.	48	Malay Peninsula, Siam, Borneo, and New Guinea.
16. *O. sativa* L.	24 and 48	India and Indo-China.
17. *O. schlechteri* Pilger	----------	New Guinea.
18. *O. tisseranti* A. Cheval.	----------	Central Africa.

[1] P.I. 269630. Collected in El Salvador by H. M. Beachell and identified by Eugene Griffith, Crops Research Division, Agricultural Research Service, Beltsville, Md., and J. R. Swallen, Smithsonian Institution, Washington, D.C.

Roschevicz (*53*) divided the species of *Oryza* into four sections on the basis of morphologic characters and geographic distribution. Kihara (*35*) modified this grouping to include species not reported by Roschevicz.

In 1963, a committee [2] reviewed the classification and nomenclature of *Oryza* and recommended that standards be adopted and used uniformly. This committee recognized 19 valid species of *Oryza*. Seventeen of these species are listed in table 2. The species not recognized by this committee that is listed in table 2 is *O. grandiglumis*. The other two species recognized by this committee are *O. angustifolia* and *O. longiglumis*. The committee also believed that certain aspects of taxonomy in *Oryza* are uncertain. These are: (1) The relation and nomenclature among the taxa commonly designated as *O. sativa* var. *fatua*

[1] Italic numbers in parentheses refer to Selected References, p. 16.

[2] This committee was appointed at the Rice Genetic Symposium convened at the International Rice Research Institute, Los Banos, the Philippines. The members were S. Sampath, India; T. Tateoka, Japan; and M. T. Henderson, United States.

(or *f. spontanea* Roschev.) and *O. perennis* (Asiatic, American, and African) subspecies and varieties; (2) the relation of the form commonly designated *O. stapfii* to *O. glaberrima* and *O. breviligulata;* (3) the relation between *O. granulata* f. and *O. meyeriana;* (4) the relation between *O. alta* and *O. grandiglumis;* and (5) the status of the taxa previously designated *O. ubanghensis* Chev. and *O. malampuzhaensis* Krish. and Chand. The committee also believed that the form commonly designated *O. subulata* should be excluded from *Oryza* and should be recognized as *Rhynchoryza subulata* (Nees) Baill.

Chatterjee (*14*) reviewed the literature on the origin and distribution of wild and cultivated rice. He concluded that the eastern part of India, Indo-China, and part of China could be considered the area where cultivated rice (*Oryza sativa*) originated. Chatterjee further concluded, as did Roschevicz (*53*), that for the genus as a whole or the section *Sativa* Roschev., the center of origin is Africa. He was of the opinion that *O. alta*, *O. australiensis*, *O. brachyantha*, *O. eichingeri*, *O. grandiglumis*, *O. latifolia*, *O. minuta*, *O. perrieri*, *O. schlechteri*, *O. subulata*, and *O. tisseranti* had little part in the ancestry of cultivated rice. This view seems to be based either on the fact that these species do not cross with *O. sativa* or on the fact that they occur naturally in areas far removed from the center where rice cultivation originated.

Many investigators have studied and discussed the origin of the genus *Oryza* and of cultivated rice (*13*, *14*, *15*, *35*, *46*, *48*, *50*, *53*, *55*, *56*, *67*, *70*). It is generally concluded that the original ancestral species may no longer exist and that present varieties evolved through progressive stages from known wild species (*56*).

Nandi (*44*) and Sakai (*54*) proposed that a species with a haploid number of five chromosomes was the ancestor of *Oryza*. This proposal was rather widely accepted. Nandi (*44*) observed that in the somatic complement having 24 chromosomes there were two members of eight types and four members of two types. The maximum association in second metaphase was two groups of three and three groups of two. It was concluded from this observation that the haploid genome of the present *O. sativa* is composed of two original five-paired species belonging to two different ancestral genomes in which two chromosomes were duplicated.

Later, Shastry, Rao, and Misra (*60*) identified 12 pachytine bivalents in a strain of *O. sativa*, based on their length and arm ratios. This finding seems to cast considerable doubt on the validity of the supposition "that *O. sativa* is a secondarily balanced allo-tetraploid which originated through hybridization between two different five-paired species in which two chromosomes were duplicated, probably due to meiotic irregularities in the hybrid. This followed by a subsequent doubling of the chromosomes attained the secondary balance of n=12, the present existing number of *O. sativa*" (*44*).

Sampath and Rao (*56*) "inferred that *Oryza perennis* is the ancestral form of cultivated rices, having given rise to *O. sativa* in Asia and *O. glaberrima* in Africa by human selection." These authors were of the opinion that *O. breviligulata* and *O. sativa* var. *fatua* are of collateral descent from *O. perennis*. The present types that are classified as *O. sativa* var. *fatua* or *spontanea* show morphologic differences that may be due to genetic transfer from cultivated rice. From this it is inferred that these wild forms are derived from hybrids with cultivated rices and are not the progenitors of cultivated rice. Instead it has been strongly suggested (*55*, *56*, *70*) that an intermediate type may be the immediate ancestor of *O. sativa*.

Description and Development of the Rice Plant and Classification of Cultivated Varieties

Cultivated varieties of *O. sativa* are divided into groups on the basis of several characters. The principal division is on the basis of sterility of the hybrid. Kato and others (*33*, *34*) observed that in crosses of certain varieties from the temperate zone and certain varieties from tropical areas, the hybrids had a high percentage of sterile florets. The hybrids between varieties within these two groups were as fertile as self-pollinated parent varieties.

They proposed that the temperate zone varieties be named japonica and the tropical zone varieties indica. Kato and others (*34*) observed no difference between japonica and indica varieties in chromosome number and behavior or in pollen formation. However, in the hybrid, pollen formation was abnormal. Serological investigations showed differences between japonica and indica varieties.

Later, Terao and Midusima (*66*) noted that another group of varieties, principally from tropical islands of Southeast Asia, were intermediate. This last group is referred to as bulu.

It appeared from the earlier studies that the varieties could be divided into three distinct groups based on sexual affinity. Mizushima (*39*), however, determined that this was not true and that sexual affinities among varieties from these groups varied gradually from one extreme to the other.

Oka (*45*) compared 147 varieties from widely different geographic areas on the basis of a number of morphologic and physiologic characters

and by observing sexual affinity in hybrids. From these studies, he placed the 147 varieties tested into indica (continental) and japonica (insular). He subdivided the japonica group into "tropical-insular" and "temperate-insular."

In a review on reports of sterility in hybrids between indica and japonica varieties, Shastry, Rao, and Misra (*60*) explained sterility on the basis of chromosome structural differences, lethal genes, inversions, paracentric inversions, genic mutations, and cryptic structural hybridity.

There are many morphologic differences between typical japonica, indica, and bulu varieties (table 3). Varieties that are known to be progenies of hybrids are intermediate in many respects.

TABLE 3.—*Characters of japonica, indica, and bulu rice varieties*

Character	Japonica	Indica	Bulu
Grain shape	Short	Long	Large.
Second foliar leaf:			
Length	Short	Long	Long.
Angle	Small	Large	Small.
Foliage color	Dark green	Light green	Light green.
Culm:			
Stiffness	Stiff	Not stiff	Stiff.
Erectness	Upright	Spreading	Upright.
Length	Short	Long	Long.
Flag leaf:			
Angle	Medium	Upright	Medium.
Shape	Narrow and short	Narrow and long	Broad and long.
Degree of emergence of upper node.	Medium	Well emerged	Not emerged.
Number of tillers	Many	Many	Few.
Pubescence	Pubescent	Variable	Variable.
Awns	None	None	Many.
Panicles:			
Number	Many	Many	Few.
Weight	Heavy	Light	Heavy.
Length	Short	Long	Medium.
Density	Dense	Medium	Medium.
Branching of rachis	Few	Medium	Many.

Source: Nagai (*40*).

Description of plant

The principal parts of the rice plant are a fibrous root system, culms, leaves, and panicles.

The fibrous root system extends outward and downward from the base of the plant. Adventitious roots that arise from the lower nodes of the culms are finely branched. The extent of the root system and the size of the roots vary with variety and type of culture.

The culm and leaves develop from the plumule. The culm consists of the nodes, which have solid centers (septum), and the internodes, which are hollow. The culms of most varieties of *Oryza sativa* are erect or ascending, although there are procumbent types. Varieties range in height from less than 15 to more than 96 inches (37 to 240 centimeters) although varieties grown in the United States range from 36 to 54 inches. The culms vary in diameter at the base from 5 to 15 millimeters. The number of nodes in the culm ranges from 13 to 16 (*32*), and the number is significantly correlated with length of growing season. Usually, four internodes elongate; the upper internode (peduncle) is usually the longest, and it bears the panicle.

The leaves of the rice plant are flat and range from 7 to 20 milimeters wide. The coleoptile usually is considered to be the first leaf. It has stomata but few chloroplasts. The mature foliage leaf consists of the sheath at the base, which surrounds the culm for some distance; the blade, which is set at an angle with the sheath; the ligule; and the auricles. The junction of the sheath and blade often is called the collar or junctura. The swollen zone at the base of the sheath where it joins the culm is the pulvinus.

The panicle of most varieties is fairly dense and drooping. There is, however, much intervarietal variation, since the panicle ranges from open to very compact and from erect to drooping. From one to three or sometimes more branches arise alternately or somewhat in whorls at each node of the peduncle. The rachilla bears the spikelet, and each rachilla arises on the same side of the rachis. Each rachilla usually has a single spikelet, although some varieties may have two or more spikelets on a rachilla. The spikelet is laterally compressed, is one flowered, and articulates below the outer glume.

The two outer glumes usually are short, that is, less than one-third the length of the lemma, al-

though there are types that have glumes as long as the lemma or longer. The lemma (inferior or lower flowering glume) is rigid, keeled, and three nerved, and has two additional thin, marginal nerves that can be seen only in section. The apiculus or tip of the lemma is sometimes prolonged to form the awn. The palea (superior or upper flowering glume) is similar to the lemma, but narrower. It has two nerves near the margin and a thin midnerve that can be seen only in section. The flower is composed of a one-carpellate pistil with a bifurcated, plumose slender style; and six stamens with yellowish, four-lobed, two-celled anthers. The principal parts of the caryopsis (brown rice) are the embryo and endosperm and the covering tissues.

Development of plant

Rice seed germinates rapidly when moisture, temperature, and oxygen are optimum. The embryo, which consists of the organs that develop to produce the rice plant, lies in a slanting position at the base of the grain on one side of the endosperm. The endosperm contains the stored food that nourishes the developing seedling until the roots have developed sufficiently to obtain nutrients from the soil.

At germination, the coleorhiza pushes through the pericarp, leaving a cavity. The primary root soon elongates, fills the cavity, and then pushes through the coleorhiza. The root extends upward for a short distance and then turns down. About this same time, the coleoptile emerges and rapidly elongates. The epicotyl below the coleoptile also elongates. Elongation varies with the depth the seed is planted. It elongates enough to bring the base of the coleoptile to the surface of the soil. When the coleoptile emerges from the soil, it splits on the side opposite the scutellum, and the foliage leaves soon appear. Usually in about 2 days, two adventitious roots start to develop in the meristematic zone on the side opposite the scutellum. A third adventitious root may appear later at the coleoptile divergence opposite the two older ones. Lateral roots soon develop from the primary and adventitious roots (*71*).

The main axis of the plant, often called the primary tiller, is differentiated rapidly. The meristematic region is at the base of the internodes; this is typical of all grasses. With three early (130-day) United States varieties, tillering started within 3 weeks after germination, and all tillers that produced panicles were formed within a 3-week period (*4*). Japonica varieties started to tiller about 14 days after transplanting and tillering was completed in 23 to 25 days (*32*). Indica varieties started to tiller about 14 days after transplanting, and all tillers were initiated in 3 to 5 weeks from this time, depending on the length of growing period of the variety (*49*). Tillers develop from buds in the axil of the node and the arrangement is alternate (*32*, *49*). Japonica varieties (*32*) develop secondary tillers from the buds at nodes 3 or 4 to 10. Tillers from node 10 often do not produce panicles. Tertiary tillers may develop from buds at nodes of the secondary tillers.

Panicle formation starts when all nodes have been formed. The length of the period from seeding or transplanting to the starting of panicle formation varies with the length of growing period of the variety. The period up to formation of the panicle primordium constitutes the "vegetative" stage. It is this period that accounts for the variation in length of growing period among varieties. Formation of the panicle primordium starts about 50 days after seeding for very early United States varieties and about 100 days for later United States varieties. The period from formation of the panicle primordium to emergence of the panicle from the sheath ranges from 24 to 31 days for indica varieties (*49*) and from 28 to 36 days for japonica varieties (*5*).

For indica varieties, the panicle primordium can be noted when it is 0.125 to 0.25 millimeters long. By the time it is 0.5 millimeters long, "hemispherical excrescences are observed at the base" (*49*). The hemispherical excrescences represent the branches of the panicle. Rudiments of the spikelet on either side of the basal axis are perceptible when the panicle primordium is 5.0 millimeters long. The panicle primordium then elongates, and the spikelets are differentiated progressively from the tip down to the base of the panicle. Spikelets in the tip and middle of the panicle have reached maximum length by the time the panicle has completed its elongation, which is 15 to 20 days after formation of panicle primordium. The spikelets at the base of the panicle complete their elongation by the time the panicle emerges from the sheath (*49*).

Similar results were reported for a variety from the Philippines (*30*). Anthesis starts the first day of emergence of the panicle. It begins with the flowers at the tip of the panicle and continues progressively at the tip of each branch of the panicle. The greatest number of flowers open the second or third day after the panicle emerges. Anthesis occurs over a period of 6 to 10 days, varying with weather and variety. It usually occurs from midmorning to shortly after noon. The time differs with variety, location, and weather (*3*, *52*). Pollen is shed just before or at the time the flower opens.

The formation and development of the embryo of a japonica variety (*65*) and of a variety from the Philippines (*30*) has been described. The process is similar in both varieties. Juliano and Aldama (*30*) reported that "development of the

megasporange, megaspore mother cell, and embryo is normal and follows very closely those reported by other investigators. The embryo sac is of the normal octonucleate type." These investigators also observed that "development of the microsporange is normal and follows those reported in many angiosperms"; that "division of the microspore mother cell is successive"; and that "long before anthesis the young microspore contains two coats, a thin peripheral cytoplasm, wherein a single nucleus is embedded, and a single germ pore." Double fertilization occurs about 12 hours after anthesis (*65*). In a japonica variety, the caryopses reach maximum length in about 12 days after flowering, maximum width or breadth (dorsoventral diameter) in about 22 days, maximum thickness (lateral diameter) in about 28 days, and maximum dry weight in about 35 days (*37*). Similar results were obtained for United States varieties; air-dry kernel weight and percentage of germination were maximum about 35 days after the first panicles emerged from the sheath (*61*).

Classification of varieties

Cultivated varieties of rice belong to the genus *Oryza* L., tribe Oryzeae, and family Gramineae. Most cultivated varieties are in the species *Oryza sativa* L., although varieties of the species *O. glaberrima* are cultivated in Africa. *O. sativa* is an annual; but when moisture and temperature are optimum and in the absence of disease, plants have survived and produced grain for 20 years or more.

All varieties of rice grown in the United States are in the species *O. sativa* L. The commercial varieties are classified on the basis of (1) length of growing season, (2) size and shape of the grain, and (3) chemical character of the endosperm. Ito and Akihama (*22*) further classified varieties on the basis of plant height, straw strength, disease resistance, and color of various plant parts.

On the basis of length of growing season, United States varieties grown in the Southern States are divided into four groups: (1) Very early (100–115 days); (2) early (116–130 days); (3) midseason (131–155 days); and (4) late (156 days or more). The length of growing season is somewhat longer in California than in the South. The difference in length of growing season between these two areas is caused by day length and temperature.

The United States varieties are divided into three grain size and shape classes: short (Pearl), medium, and long. The more slender long-grain varieties sometimes are considered a fourth class. Examples of the respective groups are Caloro, Nato, Bluebonnet 50, and Rexoro. (See "Rice Breeding and Testing Methods in the United States," p. 31.)

On the basis of chemical characters, rice types are divided into waxy (glutinous; endosperm contains no amylose) and common (ordinary starchy; endosperm contains amylose as well as amylopectin). Only a very small acreage of waxy rice is grown in the United States. The percentage of amylose in the starch in the endosperm of varieties grown in the United States varies rather widely. ("See Rice Breeding and Testing Methods in the United States," p. 38.)

A more detailed system is needed to classify the many varieties and lines used in breeding studies. Much work has been done to devise objective methods of classifying rice varieties. Previous work was summarized and a proposal for classifying rice varieties was formulated by a special committee in India (*21*). The committee proposed that rice varieties be classified on the basis of qualitative and quantitative characters. Nagai (*40*) reviewed systems used to classify rice varieties. These systems were followed rather closely in the Food and Agriculture Organization, "World Catalogue of Genetic Stocks—Rice," (*1*) and subsequent supplements. The classification system used in the United States includes the items in these systems with certain modification and additions.

Genetics

Varieties of ordinary cultivated rice, being largely self-pollinated, remain uniform and constant if care is taken to preserve pure seed. Mutations, chromosome changes, and natural crossing, however, have brought into existence a wide diversity of types and varieties that affect every part and function of the plant. Plants may be short or tall enough to grow in deep water; may have colored pigments of various shades distributed in different patterns over the plant; may tiller little or profusely; may have long and slender or short and round grains, with or without awns; and may have translucent or opaque kernels that differ in chemical composition. Also, the life cycle of one plant may be three times as long as that of another.

Differences that can be sorted into distinct contrasting classes make possible the study of segregation and recombination as well as linkage relationships of genes, which are the units of heredity. For convenience in publishing genetic studies, differences that have individual efforts great enough to be recognized are assigned gene symbols. To promote uniform usage among rice geneticists, the International Rice Commission of the Food and Agriculture Organization of the United Nations has adopted and recommended the gene symbols listed below (*2*).

Inherited differences, such as plant height, that are not clear cut but that grade from one extreme to another involve the interaction of several genes that have similar effects, but the actual number and the individual contribution of the genes involved remain uncertain.

Gene symbols adopted and recommended for rice [1]

A		
	A, A^d, a	= allelic anthocyanin activator genes (complementary action with C genes produces red or purple in apiculus)
	al	= albino [2]
	An	= Awned [2]
	au	= rudimentary auricle
B		
	bc	= brittle culm
	Bd	= Beaked hull (tip of lemma recurved over palea)
	Bf	= Brown furrow (dark brown color in furrows of lemma and palea). See H^f
	I–Bf	= Inhibitor of dark brown furrow
	bg	= coarse (big) culms
	Bh	= Blackhull (complementary genes) [2]
	bl	= physiologic diseases showing dark brown or blackish mottled discoloration of leaf
	bn	= bent node—culm forms angle at node
C		
	C, C^B, C^{Bp}, C^{Bt}, C^{Br}, c	= allelic basic genes for anthocyanin color; higher alleles have pleiotropic expression in internode
	C alone	= tawny colored apiculus
	CA	= red or purple colored apiculus
	CAP	= completely and fully purple colored apiculus
	En–C	= Enhancer of C
	Ce	= *Cercospora* resistance
	chl	= chlorina (chlorophyll deficiency)
	Cl	= Clustered spikelets, also super cluster
	cls	= cleistogamous spikelets
	clw	= claw-shaped spikelets. See tri and Bd
D		
	d	= dwarfs,[2] about ⅓ to ½ height or normal; discrete classes in segregating populations
	da	= double awn
	Dn	= Dense or "compact"; very close arrangement of spikelets (vs. normal panicle); epistatic to Ur. See Lx, also Cl
	Dn_2	= Dense vs. lax
	Dn_3	= Normal vs. lax
	Dp	= Depressed palea and underdeveloped palea
	dw	= deep water paddy, so-called floating rice
E		
	Ef	= Early flowering (low photosensitivity).[2] See Lf
	En–	= Enhancer (intensifier). Precedes symbol of character affected
	er	= erect growth habit, recessive to spreading or procumbent. See dw, la
	Ex	= Exerted vs. enclosed panicle
F		
	Fgr	= Fragrant flower
	fs	= fine stripe
G		
	g	= long glume [2] exceeding ⅓ length of the spikelet
	gh	= goldhull (golden yellowhull, recessive to straw color.) See Wh
	gl	= glabrous (nonhairy) leaf. See Lh
	Gm	= semi-dominant long glume. More extreme and less regular in expression than g. Epistatic to g
		green and white stripe; see fs, v.
H		(H or h is suggested to denote hull, i.e., lemma and palea)
	H^m, H^i, H^g, H^r	= allelic genes for nonanthocyanin colors of lemma and palea appearing only in the presence of Gh; goldhull colors appear with gh
	He	= *Helminthosporium* resistance
	hsp	= hullspot
I		
	I	= positive vs. negative staining with iodine–potassium iodide solution
	I–	= inhibitor (precedes symbol of character inhibited)
K		(K or k is suggested to denote kernel, i.e., caryopsis)
L		(l (as second letter of a symbol) is suggested to denote leaf.)
	l–	= lethal (precedes symbol of character having lethal effect)
	la	= lazy. See er
	Ld	= Lodging
	Lf	= Late flowering (highly photosensitive).[2] See Ef
	lg	= liguleless (auricle and collar also absent) [2]
	Lh	= very hairy (long hair) dominant to ordinary pubescence. See gl
	lk	= grain length (long grain) [2]
	lmx	= extra lemma
	lu	= lutescent
	Lx	= Lax vs. normal panicle. See Dn
	Lx_2	= Lax vs. compact
M		
	me	= multiple embryos (polyembryonic)
	mp	= multiple pistils (polycaryoptic)
		mottled leaf; see bl
N		
	nal	= narrow leaf
	nl	= neckleaf
	nk or I–Nk	= notched kernel
O		
	o	= open hull (parted lemma and palea)
P		(P (as first letter of a symbol) is suggested to denote anthocyanin color.) Exceptions: Ph, Pi
	P	= Completely purple apiculus (complementary action with C and A)
	Pau	= Purple auricle, basic to Plg
	Pg	= Purple outer glumes
	Ph	= Phenol staining of hull and bran
	Pi	= *Piricularia* resistance

[1] Recommended by the Eighth (1959) FAO International Rice Commission Working Party on Rice Production and Protection; the list includes present revisions.

[2] More than one gene involved; subscripts to be supplied by workers as needed. Letter subscripts are suggested for complementary genes, numeral subscripts for genes having phenotypically similar effects and also for polymeric genes.

Pin = Purple internode. See C
Pl = Purple leaf. See Pw
Pla = Purpleleaf apex (complementary action with C and A)
Plg = Purple ligule. See Pau
I–Pl = colorless leaf except margin
Pn = Purplenode
Pr = Purplehull (lemma and palea) (complementary action with CAP)
Prp = Purple pericarp
Ps = Purple stigma (complementary action with CAP)
Psh = Purple sheath
Pu = Purple pulvinus
Pw = Purplewash. See Pl
Px = Purple axil

R

Rc = Brown pericarp (basic to Rd)
Rd = Red pericarp (complementary action with Rc)
ri = verticillate (whorled) arrangement of rachis ("rinshi" character)
Rk = Round spikelet (kernel)
rl = rolled leaf

S

s = sterility [2]
Sc = *Sclerotium oryzae* resistance
Se = Photosensitivity. See Ef, also Lf
Sh = Dominant shattering as in drop-seed or wild types vs. difficult or intermediate threshing. See th
Sk = Scented kernel
sn = sinuous neck. See Ur
spr = spreading panicle branches spreading growth habit; see er, also la superclustered spikelets; see Cl

T

(T is suggested to denote plant height ("Tallness") except where controlled by dwarfing genes.) See d
I–T = short nondwarf plant vs. tall
tb = tipburn yellow
Tf = Tough dehulling
th = shattering or easy threshing recessive to difficult separation. See Sh
tl = twisted leaves
tri = triangular hull (spikelet). See clw

U

Ur = Undulate rachis vs. normal. See sn

V

v = virescent, also green and white stripe. See fs

W

wb = white belly (endosperm)
wb_2 = white core (endosperm)
Wh = Whitehull, epistatic to gh
wx = waxy (glutinous) endosperm

Y

y = yellow leaf
l–y = lethal yellow, also xantha [2]

Z

z = zebra stripe

Plant colors have been studied more extensively than other characters in rice because they are readily classified, and it is possible to analyze precisely the genic action and interaction. From the economic standpoint, colors are of limited importance. Red bran color usually is objectionable as a mixture in ordinary white rice; purple bran varieties are used locally for rice wine or special preparations; purple leaf varieties have been distributed for growing in red-rice infested areas, so that the weedy type may be identified in the seedling stage and pulled out.

The segregation and interaction of color genes in Japanese varieties have been analyzed thoroughly (*62*). Purple (anthocyanin) colors, if present, ordinarily are manifest at least in the apiculus. The gradations from dark purple to pink and colorless were found to be controlled by five allelic chromogen genes, C^B, C^{Bp}, C^{Bt}, C^{Br}, and c. However, C genes alone produce no color in the flowering stage but are responsible for brown colors in decreasing intensity, which appear as the spikelet matures.

Activator gene A also must be present to convert the basic color pigment to purple anthocyanin. There are three allels at the A locus. A third gene P, present in all but a few varieties, brings out distinct coloration. The numerous colors produced in the apiculus by the interactions of the C and A allels in the presence of P are shown in table 4.

The C^B allel in the presence of A and A^d also has pleiotropic effect, producing color in the internode. C allels with A and also less distinctly with A^d result in colored outer glumes.

TABLE 4.—*Apiculus colors resulting from interaction of C and A allels in the presence of the P gene in Japanese rice*

Activator allels	C^B	C^{Bp}	C^{Bt}	C^{Br}	c	Color at time indicated
A	Purple	Red purple	Red	Pink	Colorless	Flowering.
	Purple	Red purple	Red	Colorless	do	Maturity.
A^d	Deep red	Red	Orange tinge	Orange tinge	do	Flowering.
	Brown	Light brown	Yellow tinge	Colorless	do	Maturity.
a	Colorless	Colorless	Colorless	Colorless	do	Flowering.
	Dark brown	Brown	Light brown	Yellow tinge	do	Maturity.

Source: Takahashi (*62*).

Combinations of C and A are basic to the appearance of color in other parts of the plant as well as in the apiculus. Purple color of inner glumes (lemma and palea), leaves, and nodes was shown to result from the complementary action of C and A with Pr, Pl, and Pn, respectively.

The expected segregation ratio in the F_2 of a cross between a line with purple apiculus and inner glumes and a completely colorless line is given below to illustrate the many color patterns that appear as the result of recombinations of color genes.

Ratio of gene combinations	*Color patterns*
27 C A Pr	Purple apiculus and glumes.
9 C A pr	Purple apiculus, colorless glumes.
9 C a Pr	Brown (tawny) apiculus and glumes.
3 C a pr	Brown (tawny) apiculus, colorless glumes.
16 c	All combinations with c are colorless.

Many of the segregation ratios previously reported in publications in Japan and other countries can now be reinterpreted with fewer assumptions in accordance with the above analysis. Other workers had recognized two basic complementary color genes, but the pleiotropic action and the existence of multiple allels had not been fully realized.

Indian workers (*50*) have established an allelic series for another set of glume colors: H^m, mottled; H^l, piebald; H^g, green changing to straw at maturity; and H^f, dark furrow color. These colors appear only in the presence of the gene for strawhull color, Gh; and with gh, only goldhull colors appear.

Purple bran appears in varieties apparently lacking pigmentation in all other parts and segregates in 3:1 ratios in crosses with colorless bran. A cross between a purple bran line that carried a gene for red bran and a colorless line gave 9 purple-red:3 purple:3 red:1 colorless (*9*). The red underlaid the purple in such a way that it was possible to separate the first two classes. A cross between a purple bran line having colorless vegetative parts and a line having ordinary bran and partly purple leaves segregated in the F_2 generation in a ratio of 13 colorless or partly purple leaves to 3 fully purple leaves. The results show that an inhibitor gene restricts expression of full purple leaf color. Purple leaf appeared only in the presence of purple bran.

Red rice varieties are grown in southern India, in Ceylon, and in other areas; but red-rice mixtures in white milled rice detract from the appearance. Work reported from Japan (*41*) showed that red bran color required two genes for expression. A gene Rc for brown bran is basic, and with Rd the bran is bright red. Rd and A are closely linked; this makes it appear that the apiculus color gene is basic for red. In a cross between a red line of the genetic constitution C A Rd Rc and colorless C a rd rc, the segregation is 9 red bran, colored apiculus:3 colorless bran, colored apiculus:3 brown bran, colorless apiculus:1 both bran and apiculus colorless. In this cross, red bran is found only with colored apiculus and brown bran only with colorless. In the cross C A Rd Rc × c a rd Rc, on the other hand, red bran occurs with and without colored apiculus; but brown bran never occurs with colored apiculus. The F_2 ratio is 9 red bran, colored apiculus:3 brown bran, colorless apiculus:3 red bran, colorless apiculus:1 both bran and apiculus colorless.

The existence of varieties with life cycles that range from as short a period as 3 months to about 10 months contributes greatly to the wide adaptability of rice to different areas and conditions. Varieties are classified for time of flowering as photosensitive or as insensitive. The photosensitive class includes late-maturing varieties, which remain in a vegetative stage while the days are long but probably enter the flowering stage when the night period reaches a critical length. In Ceylon, differences in varietal response to variations of less than an hour in day length were found and were controlled by one dominant gene for sensitivity (*11*). Early varieties tend to enter the flowering stage after the completion of a fairly constant vegetative stage.

In Japan, a series of six maturity genes dominant for lateness and having accumulative effects have been postulated (*40*). The action of these genes is conditioned by temperature. Sampath and Seshu (*57*) reported an Indian study that dealt with crosses of two varieties from Japan with photosensitive Indian varieties. One Japanese variety was insensitive and the other photosensitive in Japan; but under the temperature and day length conditions at Cuttack, India, both flowered early (48 and 68 days from seeding, respectively). The F_1 plants of crosses of the Indian varieties with the insensitive Japanese variety flowered early, and segregation in the F_2 generation was 3 early:1 late or 15 early:1 late. However, in crosses between the photosensitive Japanese variety and Indian varieties the F_1 plants flowered late and segregation in the F_2 generation was 1 early:3 late or 1 early:15 late. It was assumed that in the crosses with the photosensitive parent, genes involved in temperature responses and modifying the photoperiodic response were segregating. These authors cite a Japanese study in which a gene for late flowering was found to be epistatic to one for early flowering.

In Louisiana, a cross between varieties that headed in 90 and 125 days was studied (*8*). The F_2 segregation was bimodal and indicated the action of one major gene for earliness.

Disease resistance can be analyzed genetically if distinctly resistant and susceptible classes occur. Specialized races of fungus diseases must be taken into account; usually segregation is best

determined following inoculation with cultured spores of individual races. Single and duplicate genes for resistance to four races of *Cercospora oryzae* I. Miyake, the fungus that causes narrow brown leaf spot, have been determined (*27*). No linkage was found between genes for *Cercospora* resistance and the chromosome marker genes C apiculus color, H^f furrow color, gh goldhull, and wx waxy (*26*).

Several types of genetic segregation have been reported for inheritance of resistance to *Piricularia oryzae* Cav., the fungus that causes blast. As early as 1922, resistance was reported to be controlled by a single dominant gene (*40*). However, no work has been reported on segregation of resistance to established races. In 1960, a laboratory study of three crosses was reported from India (*7*). Survival was controlled by one or two dominant genes, but the surviving plants and the parents showed rather high degrees of susceptibility.

Awns are a conspicuous morphologic character. Although little is known of their physiologic value to the plant, they are supposed to be associated with general hardiness (*50*) and to offer some protection against pests. Awns are objectionable in threshing and handling the grain. The development of awns varies considerably with environmental conditions. Varieties that show mere tip awns at moderate levels of fertility may develop much more prominent awns at higher levels. In Louisiana, the Caloro variety develops awns when seeded very early but may be practically awnless when seeded late. In the F_2 generation, ratios of awned to awnless plants of 3:1, 15:1, and 9:7 have been reported from India, Japan, and the United States. These ratios show, respectively, that single, duplicate, and complementary genes act to produce awns. A study in California (*28*) showed that fully awned plants differed from awnless by two genes, fully awned from partly awned by one gene, and partly awned from awnless by one gene.

Most rice varieties have pubescent leaves and hulls, although a few are essentially glabrous. Pubescence has been eliminated from the varieties grown in the Southern United States. In most varieties, a single gene pair Gl:gl controls the development of plant hairs on all outer surfaces of the plant. However, some varieties have some pubescence on the leaf surface, although the lemma and palea are smooth. Nagao, Takahashi, and Kinoshita (*43*) reported the segregation in crosses of the latter type with ordinary pubescent Japanese types. Three classes of pubescence plus glabrous appeared in the F_2 generation in ratios of 9:3:3:1 and 27:9:21:3. It was concluded that two genes Hl_a and Hl_b together but not singly bring about the development of hairs on the leaf surfaces even in the presence of gl.

The strength of attachment of spikelets to their pedicles is of practical importance to the grower. Shattering (shedding) of grain in the wind, which occurs in red rice, would make it impossible to harvest the crop; whereas at the other extreme, which occurs in some of the Japanese varieties, the attachment is so tight that in combining much grain would remain on the straw. Types that thresh free of the straw yet do not shatter easily are needed for mechanized harvest. Easy threshing Sh is dominant to intermediate or tough threshing sh; but, on the other hand, tough threshing is dominant to intermediate threshing.

Multiple gene inheritance of grain length was reported in a study in the United States (*29*). In crosses of short × medium, short × long, and medium × long types, variation in length in the F_2 generation was continuous. Similar results, also showing transgressive segregation, were obtained for breadth of grain.

Tillering ability is of great importance where rice is transplanted, but much less so where direct seeding at relatively high rates is practiced. Ramiah and Rao (*50*) reported from India that the F_1 plants of three crosses were intermediate for number of tillers per plant, and the F_2 progenies showed transgressive segregation. In one cross high correlation between the number of tillers in F_2 plants and their respective F_3 progenies indicated that the controlling genes are limited in number—probably no more than three or four. In another cross the occurrence of numerous F_3 progenies, each comparatively uniform in number of tillers, led to the same conclusion.

Standing ability or lodging resistance is a complex character that is difficult to measure in inheritance studies. In a study reported from India (*50*), the F_2 progenies of a cross segregated 3 lodging:1 nonlodging, but the latter were low tillering and late maturing.

In Louisiana, a cross between an early-maturing, medium-grain selection and the late-maturing variety Rexoro indicated transgressive segregation for yield (*8*). F_4 lines were recovered that had yields significantly higher than those of the high-yielding parent, but none had yields significantly lower than those of the low-yielding parent. Higher yield was strongly associated with earlier maturity. No correlation was found between yield and spikelet length and breadth, or between yield and grain weight.

In correlation studies from other countries Ramiah and Rao (*50*) indicate association of higher yield with number of tillers, number of grains per ear, and plant height.

Genetic information on the quality character of rice is very limited, although the single gene segregation between common and waxy types was one of the first characters studied. The inherit-

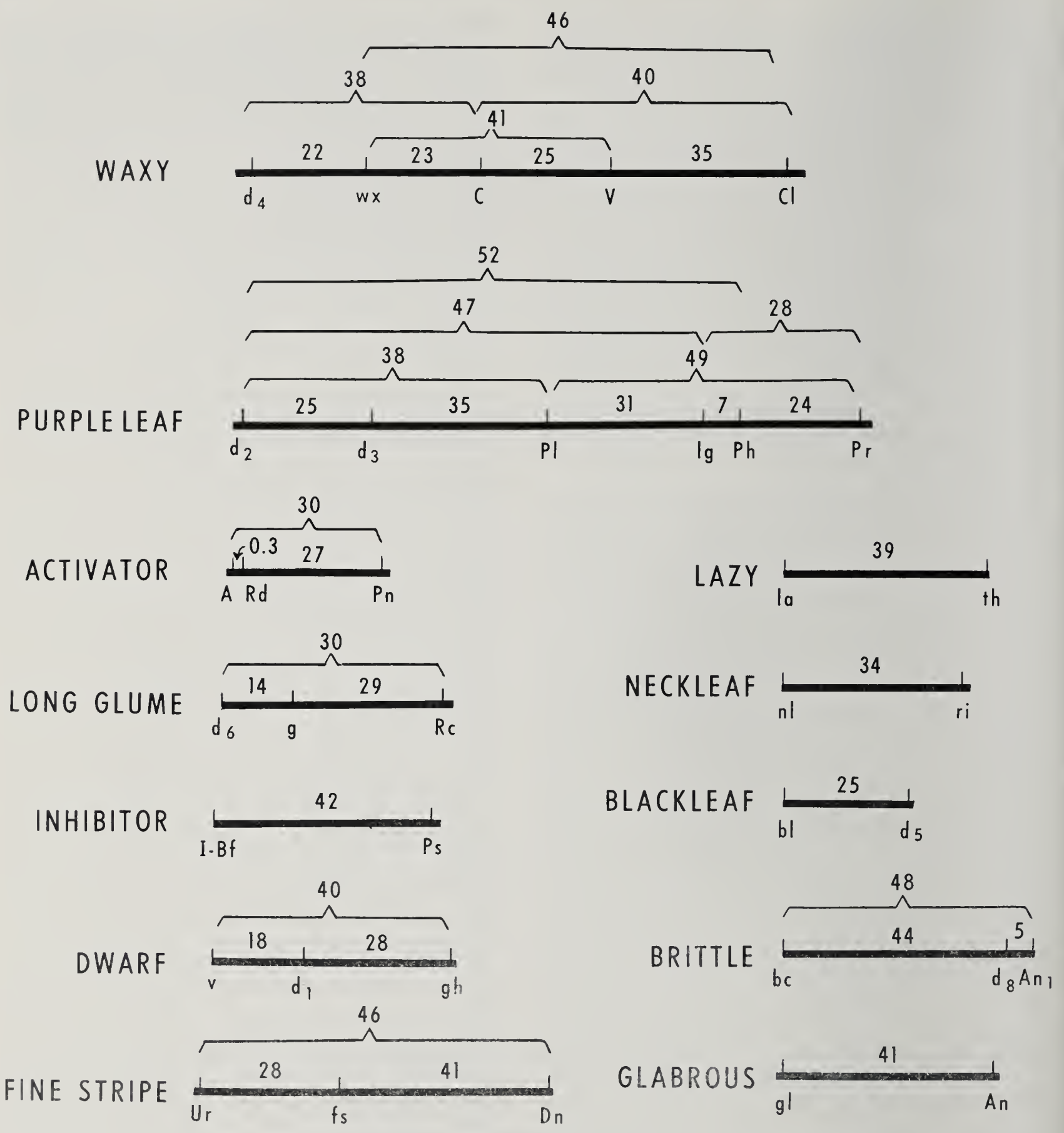

FIGURE 5.—Rice linkage groups.

ance of amylose content as indicated by the iodine value was studied in a cross of Toro (high iodine value) × Texas Patna (low iodine value) (*58*). The value in the F_1 generation was low, indicating partial dominance. A bimodal distribution was obtained in the F_2, indicating dominance of one major gene for low iodine value. An association was shown between low iodine value and colored apiculus; the latter is also a character of the low iodine parent. Recovered lines with high iodine value were much more numerous in the early-maturing than in the late-maturing group.

Linkage refers to the closeness of association in inheritance of genes located on the same chromosomes. Genes controlling characters that segregate into clear-cut classes and that are viable are useful for determining linkage relationships. Several of the genes for color are suitable marker genes. Easily classified morphologic characters dependent on single genes are also useful, includ-

ing some of the more conspicuous characters such as awns, long outer glumes (of which recessive and semidominant types are known), pubescence, neckleaf, liguleless, lazy (ageotropic), brittle culm, numerous dwarfs, waxy endosperm, and viable types of chlorophyll deficiencies.

In a report from Japan, Nagao and Takahashi (*42*) presented data that established 12 linkage groups, representing, as expected, the number of chromosomes found in rice. Takahashi (*63*) has since amplified the information on the linkage groups. The linkage diagrams (maps) shown in figure 5 are based on the Japanese results. Data from other studies and reviews (*2*, *23*, *24*, *25*, *38*, *63*) are provisionally included with the groups to which they appear to belong. Linkages between genes that have been reported but not definitely located on the respective chromosomes are listed in table 5. Linkages between genes that have been reported but have not been assigned to a linkage group are also shown in table 5. Linkage maps of rice are much less complete than those of barley and maize.

TABLE 5.—*Linkages not definitely located on the respective chromosomes*

Linkages tentatively assigned to groups	Percentage recombination [1]	Authority
WAXY GROUP		
wx vs. Pla	45	Nagao and Takahashi (*42*).
C vs. H^t	29	Ramiah and Rao (*50*).
C vs. Se	16	Chandraratna (*10*).
C vs. Lf	32	Yamaguchi (*68*).
C vs. dp	Unknown	Nagamatsu and Ohmura.[1]
C vs. n	do	Do.[1]
1 vs. d_{21}	[2] 17?	Jodon (unpublished).
wx vs. x_1	Unknown	Oka (1953).[1]
wx vs. y_1	do	Do.[1]
PURPLE LEAF GROUP		
Pl vs. An	29?	Jodon (unpublished).
Pl vs. lop	Unknown	Nagamatsu and Ohmura, 1961.[1]
lg vs. Wh	8	Jodon (*24*, *25*).
lg vs. Xa	Unknown	Nishimura.[1]
Pr vs. P	32?	Jodon (unpublished).
P vs. (blackspot)	33?	Do.
Pr vs. lg	30	Richharia and others (*51*).
Pr vs. Px	9	Do.
Px vs. Psh	6	Do.
Pr vs. gh	32	Jodon (*24*, *25*).
Pr vs. h	36	Do.
gh vs. Wh	Unknown	Do.
Ps vs. Pr	do	Hsieh (*20*).
d vs. Pl	do	Do.
Pi vs. lg	do	Do.
ACTIVATOR GROUP		
A vs. bn	23	Hsieh (*19*).
bn vs. d_{22}	28	Do.
d_{22} vs. lgt	16	Do.
lgt vs. bn	30	Do.
A vs. d_{22}	37	Do.
Rd vs. Pin	21	Ramiah and Rao (*50*).
LONG GLUME GROUP		
d_6 vs. d_7	39	Nagao and Takahashi (*42*).
g vs. Rk	8	Kadam and D'Cruz (*31*).
Apic vs. g	17	Do.
LONG GLUME GROUP—Con.		
Rk vs. I–An	31?	Jodon (unpublished).
Pin vs. Rc	Unknown	Ramiah and Rao (*50*).
Rc vs. Lf_x?	22	Yamaguchi (*69*).
INHIBITOR GROUP		
Ps vs. Psh	10	Chao (*12*).
Ps vs. Apic	9	Shafi and Aziz (*59*).
Apic vs. Psh	12	Do.
Ps vs. Pr	2	D'Cruz (*17*).
DWARF GROUP		
gh vs. An_3	43	Nagao and Takahashi (*42*).
gh vs. P or Pr	30	Jodon and Chilton (*26*).
FINE STRIPE GROUP		
None		
LAZY GROUP		
La vs. d	Unknown	Nagamatsu and Ohmura.[1]
NECKLEAF GROUP		
nl vs. An	32?	Jodon (unpublished).
GLABROUS GROUP		
gl vs. H^g	39	Nagao and Takahashi (*42*).
LINKAGES NOT ASSIGNED TO LINKAGE GROUP		
Rk vs. An	14 and 24	Anandan (*6*).
Bh vs. An	21	Kuang (*36*).
Bh vs. Pin?	17	Parnell, Rangaswami Ayyangar, and Ramiah (*47*).
An vs. d	11	Kuang (*36*).
Pr? vs. Plg?	13	Hebert (*18*).
Pr? vs. Pin	10	Do.
Purple collar vs. Prp	13	Breaux (*9*).
Psh vs. Prp	16	Comeaux (*16*).
bl vs. Prp	Unknown	Jodon (unpublished).
d_{21} vs. Prp	do	Do.
sk vs. Prp	do	Ramiah and Rao (*50*).

[1] As reported by Takahashi (*63*).

[2] Entries followed by question marks have not been verified and may be changed as more information becomes available.

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RICE BREEDING AND TESTING METHODS IN THE UNITED STATES

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History and Objectives

Rice improvement in the United States has been discussed by Jones (*55*),[1] and the descriptions and performance of varieties developed have been reported by several authors (*1*, *2*, *25*, *42*, *43*, *48*, *52*, *57*, *58*, *59*, *67*). Although some work to improve United States rice varieties was done before 1909, it was not until about then that comprehensive, cooperative rice-breeding studies were started in the United States. Objectives of the rice-breeding program and methods used have been described (*7*, *18*, *55*, *69*). According to a report by the Rice Millers Association,[2] all rice varieties grown in the United States in 1963 evolved from these cooperative rice-breeding experiments.

Although introductions were made by individuals after the original introductions into South Carolina in the 17th century, little effort was made by Federal or State agencies to improve rice varieties until work was started by the U.S. Department of Agriculture in 1899. At that time Seaman A. Knapp, an explorer in the Division of Botany, introduced from Japan 10 tons of Kiushu rice that was distributed in southwestern Louisiana and probably in eastern Texas, where he arranged farm demonstrations of rice varieties and cultural methods. Many varieties were introduced and tested by Department workers on demonstration farms in Louisiana and Texas, and later in Arkansas and California, before the establishment of rice experiment stations in these States.

The Rice Experimental Station at Crowley, La., was established in 1909. The Biggs Rice Field Station at Biggs, Calif., (now the Rice Experiment Station) and the Rice Experiment Station at Beaumont, Tex., (now the Rice-Pasture Research and Extension Center) were established in 1912. The Rice Branch Experiment Station at Stuttgart, Ark., was established in 1926. Rice investigations were started at the Delta Branch Experiment Station, Stoneville, Miss., about 1951. Rice-breeding investigations are conducted cooperatively by the U.S. Department of Agriculture and the State agricultural experiment station at each of these locations. The rice-breeding studies were started in Louisiana in 1909, in California in 1912, and in Arkansas in 1931. Although a comprehensive rice-breeding program was not started in Texas until 1931 and in Mississippi until 1958, some breeding work had been done in these States before these dates.

Most of the early work consisted of testing selections from foreign introductions and commercial fields. Many varieties, such as Caloro, Colusa, Fortuna, Nira, and Rexoro, were developed and released from 1909 to about 1937.

S. L. Wright, a farmer in Louisiana, developed several rice varieties by selection. These varieties probably were progenies of natural hybrids between varieties, such as the long-grain Honduras and the short-grain Shinriki. The most widely grown varieties developed by Wright were Blue Rose and Early Prolific, which are medium-grain types, and Edith and Lady Wright, which are long-grain types. None of these varieties were grown in 1963, but they were the leading varieties in the southern rice area from about 1915 to 1940.

During the early years, no attempt was made to improve varieties by hybridization. Although a few hybrids had been made at experiment stations in the southern rice area at an earlier date, it was not until after 1922 that this method of breeding was used.

The primary objective in rice breeding in the United States is to develop varieties that will assure a maximum and stable production of the types of rice required by producers and consumers. Emphasis is given to developing short-season varieties. Short-, medium-, and long-grain types—with a wide maturity range within each grain type class—should be developed. The objectives of that program are to develop varieties that (1) germinate quickly and grow rapidly in the seedling stage; (2) tolerate low temperature in the germinating, seedling, and flowering stages and tolerate low irrigation water temperatures during the entire growing season; (3) are resistant to alkaline and saline soils and to salt in the irrigation water; (4) are resistant to diseases and insects; (5) have short, stiff straw and resist lodging; (6) respond to and make efficient use of maximum rates of fertilizer; (7) mature uni-

[1] Italic numbers in parentheses refer to Selected References, p. 62.

[2] Shown printed in Rice Jour. 66(12) : 14–15. 1963.

formly and produce seed that has a period of dormancy so that the grain will not germinate when harvest is delayed by rain; (8) produce maximum field and milling yields when grown under a wide range of environmental conditions; and (9) have the desired cooking and processing qualities required by domestic and foreign trade.

Each of these objectives is important in each rice-producing area in the United States, although some of the objectives are more important in one area than in another. For example, cold tolerance, especially tolerance to cold irrigation water, is more important in California than in the southern rice area. Disease resistance, on the other hand, is more important in the southern rice area than in California.

Cultural Methods and Equipment for Breeding Rice in the United States

Land for rice-breeding experiments should be of uniform soil type and topography. A gradual and uniform slope is desirable to afford reasonably rapid drainage when necessary. However, the slope should be such that blocks of three-tenth acre or larger can be uniformly irrigated without contour levees.

In the United States it is customary to locate roadways at 200- to 300-foot intervals running in the direction of the fall of the land and wide enough to accommodate field equipment and other vehicles. The road ditches are used for drainage and are paralleled by border levees. The entire area should be graded to a uniform slope before roadways and irrigation laterals are constructed. Cross levees at designated points divide the field into areas of approximately one-tenth acre that can be irrigated or drained independently (fig. 6). Larger blocks can be formed by eliminating one or more cross levees. Irrigation laterals parallel roadways and are located midway between the roadways or directly adjacent to one side of the roadways.

Ricefield machinery is used to build levees. In heavy clay soils, a steel-bladed levee builder (fig.

FIGURE 6.—Seeded nursery plots. Some of the plots are irrigated.

FIGURE 7.—Constructing levees in the nursery with a steel-bladed levee builder.

7) is used; in the more loamy soils, a disk-type levee builder (fig. 8) is used. Usually the cross levees have an 8- to 10-foot base. A concrete levee packer is useful in packing newly constructed levees. A concrete tile, 4 to 6 inches in diameter, is placed at the lower end of each block to drain the water into the road ditch so that it will hold the irrigation water. The tile is closed with a metal plate. Sometimes plastic tube siphons are used to irrigate from the lateral or to drain the water into the road ditch.

In the southern rice area, it is customary to plow down the cross levees after each rice crop and to cultivate the fields with ricefield equipment. The irrigation laterals and border levees may or may not be torn down. After cross levees have been plowed down, the areas are disked or plowed and are leveled with a land plane. A 3-year rotation system is practiced in Arkansas and Louisiana. In Arkansas, the land may be cropped to soybeans the first year. The soybeans may be harvested or turned under or disked into the ground as green manure, after which a winter grain crop may be sown. The grain crop may be overplanted with lespedeza the following spring. The grain crop is harvested in early summer, and the lespedeza is harvested for hay or seed in the summer or fall. The field is plowed or disked, and land is leveled during the winter and early spring preparatory to seeding rice the following year. In Louisiana, the land is fallowed when not in rice.

A 3-year rotation system is also practiced in Texas. It consists of 1 year of rice followed by 2 years of summer fallow. The first summer after rice is grown and harvested, the field is fallowed and then clover or ryegrass is sown in the fall. The crop is harvested for hay or seed in the spring, and the field is summer-fallowed throughout the second summer. Land is leveled during the second summer as time and weather permit.

On clay soils the cross levees are reconstructed in the late fall or winter before the fields are seeded again with rice. After cross levees are constructed, the land is prepared by using lift-type implements attached to a lightweight farm tractor. On silt loam soils the cross levees may be made immediately after seeding.

In California, a 2-year rotation generally is used in rice-breeding nurseries. The land is plowed in the winter or early spring after the rice crop has been grown and harvested. The fields usually are irrigated one or more times during the summer when they are not cropped to rice to germinate weed, grass, and rice seeds. The field is cultivated after each irrigation to destroy the plants that emerge.

Permanent levees are maintained in some of the areas used for rice nurseries. In other areas, plastic levees are used, or earthen levees are constructed with a bulldozer or front-end loading tractor each year before seeding.

Weeds and grass are controlled on lateral and drainage ditch banks, levees, and alleyways in rice by spraying with a contact herbicide.

Various types of seeding equipment are used.

FIGURE 8.—Constructing levees in the nursery with a disk-type levee builder.

In field plot varietal experiments, seeds are sown with small grain drills or specially equipped drills. In yield trials on nursery plots or in experiments where multiple seed sources are involved, belt-type seeders (fig. 9) or other readily cleaned drills are used for seeding. Breeding nurseries involving numerous panicle-row selections are sown by dribbling seed into a single-row manually operated drill (fig. 10) or a multiple-row power-operated drill.

On experimental plots uniform application of known amounts of fertilizer materials is difficult. A basal application of phosphorus and potassium may be applied with a conventional fertilizer distributor before seeding rice or to one of the other crops grown in rotation with rice. Although the fertilizer usually is distributed by a tractor-drawn implement, it may be distributed by airplane. In the southern rice area, the nitrogen fertilizer for breeding trials usually is applied as a topdressing, although sometimes part or all is applied at seeding time.

Various methods and devices have been used to apply fertilizer to rice grown in breeding nurseries. Weighed amounts of fertilizer are applied by hand as a topdressing. Mechanized fertilizer distributors have been tried with only limited success. Most devices are slower than hand application, do not apply or distribute uniform amounts of fertilizer, and can be used only on relatively dry soil.

At Stuttgart, Ark., a manually operated "planter" is used to apply nitrogen fertilizer between alternate rows when the soil is dry (fig. 11). At Crowley, La., a single-row seeder that has an agitator-type fertilizer attachment with a separate shoe places fertilizer just below the seed.

FIGURE 10.—Manually operated seeder used to seed selections.

FIGURE 9.—Belt seeder, mounted on a small tractor, used for seeding nursery yield experiments.

For a number of years a fertilizer distributor attached to a 3-row seeder was used at Beaumont, Tex. This drill used regular grain drill fertilizer distributor parts. Top-feed and other hopper-type distributors have been used with limited success to topdress plots. A force-feed type distributor that drops the fertilizer on the soil surface is fairly successful (fig. 12). Cross-plot fertilizing with this type distributor appears to be desirable in overcoming irregularities of distribution.

Because rice nurseries are likely to be muddy at harvesttime, mechanical harvesting equipment is not used. Hand sickles are used to harvest small plots; combine harvesters may be used to harvest large plots.

Bundles from small plots are air dried by hanging in a drying shed or by using heated-air driers. When dried by heated air, the bundles are placed in drying trays as harvested and dried over a tunnel or rack-type drying unit with forced heated

FIGURE 11.—A distributor used to apply nitrogen fertilizer between the rows as a topdressing.

FIGURE 12.—A force-feed fertilizer used to distribute nitrogen as a topdressing.

air (fig. 13). Bundles are left in the trays until the grain is ready to be threshed.

Bundles from large plots are threshed in a Vogel thresher (fig. 14) or a modified Kansas-type nursery thresher (fig. 15). Sometimes the concave teeth are removed to reduce breakage. Threshing rice is primarily a stripping action, and breakage is avoided when concave teeth are not used and cylinder speed is reduced. Breakage caused by improper adjustment of the thresher should be avoided because it causes a bias of grain yield and milling quality.

In some instances, bundles are placed on the cross levees for a few hours after cutting and are threshed the same day. The threshed grain is placed in cloth bags and artifically dried with forced air heated to between 90° and 100° F.

Threshed samples usually are cleaned before weighing for yield determinations. It may also be necessary to break off awns and attached fragments of rachises. This is accomplished by placing the sample in a section of automobile innertube and pounding several times. An easily cleaned aspirator, dockage machine, or small fanning machine can be used to remove foreign material. If the threshed samples are relatively free from foreign material, the grain weight can be obtained before cleaning.

Maintenance of viable seed of varieties and breeding lines is important in a rice-breeding program. The main causes of rapid deterioration of seed viability are moisture content of the seed and storage temperature. A method of drying the seed and storage facilities with low humidity and low temperatures are needed.

The moisture content of the grain is probably more important than temperature in retaining viability. Rice with a moisture content of 10 percent or below (wet basis) retained viability for several years at Beaumont, Tex. The temperature in the storage room ranged from 70° to 90° F., and the relative humidity was below 50 percent most of the time.

The moisture content of rough rice can be reduced to 4.7 percent (wet basis) when stored 42 days over a saturated solution of lithium chloride (*60*). The moisture content of rice can be reduced to about 6 percent with a silica gel drying unit (fig. 16). Rice reduced to this moisture content probably will retain viability for 5 years or longer when stored at room temperatures.

At Beaumont, Tex., seed of rice varieties, breeding lines, and genetic stocks is dried in a silica gel drier to about 6-percent moisture and stored with silica gel in sealed 1.2-cubic foot metal containers at about 34° F. About 2 pounds of silica gel is put in each container. An indicator, such as cobalt chloride crystals or paper, that changes

FIGURE 13.—Drying bundles of rice in trays with forced heated air.

color with increase in moisture is used, so that an increase in moisture is easily detected. The silica gel is usually changed every 2 years. Seed can be stored in polyethylene bags with silica gel. However, since these bags do not exclude all the moisture, the silica gel must be changed more frequently.

At Crowley, La., and Beltsville, Md., seed is stored at a temperature of about 0° F. Seed stored in this manner has retained its viability for more than 20 years.

Breeding Methods

The three major breeding methods commonly used for small grain have been used in rice breeding (*55*). These are (1) introduction of varieties from foreign countries, (2) selection of pure lines from commercial and introduced varieties, and (3) creation of new varieties by hybridization followed by selection. Irradiation breeding also has been used in the United States.

The varieties now grown in the United States were developed by using progressively the three major methods. For example, the Gulfrose variety was selected from the progeny of a cross between a selection from an introduced variety and a pure line selection from a commercial variety.

Introduction

The introduction of varieties from other countries has been and still is an important source of germ plasm for rice breeders in the United States. Some of the introduced varieties have been developed by breeders in the country of origin, and others have been indigenous varieties grown for many years by farmers in the country of origin.

FIGURE 14.—Threshing breeder seed with a Vogel thresher.

According to Jones (*55*), few varieties were introduced from about 1685 to 1889. It became evident then that the varieties being grown in the United States were not as productive as varieties grown in other countries. Starting about 1890 and continuing to the present, many varieties have been introduced. Jones (*55*) listed and described nine varieties that were introduced from other countries and grown in the United States. These were Carolina Gold, Carolina White, Early Wataribune, Honduras, Kiushu, Omachi, Onsen, Shinriki, and Wataribune. About 1935, Asahi was introduced from Japan by T. M. Sabora, a Texas rice farmer. He increased this variety for commercial production about 1940 (*57*). Thus, there have been at least 10 introduced varieties that have been grown rather extensively. None of these varieties are now of commercial importance.

Varieties now introduced into the United States are grown the first year in a greenhouse away from rice production centers to avoid the introduction of diseases and insects. The seed produced in the greenhouse then is sown in a single-row plot at one of the rice experiment stations. Notes are taken on such characters as seedling vigor, straw strength, plant height, length of growing season, grain type, kernel characters, and reaction to diseases and insects. Whether the variety is a pure line or consists of mechanical or hybrid mixtures is also noted. Varieties that appear to have no desirable characters are discarded. Varieties that have some but not all desirable characters are held in reserve for possible future use in the breeding program. Varieties that look promising in all respects in the

FIGURE 15.—Threshing bundles of rice from nursery yield experiment with a modified Kansas nursery thresher.

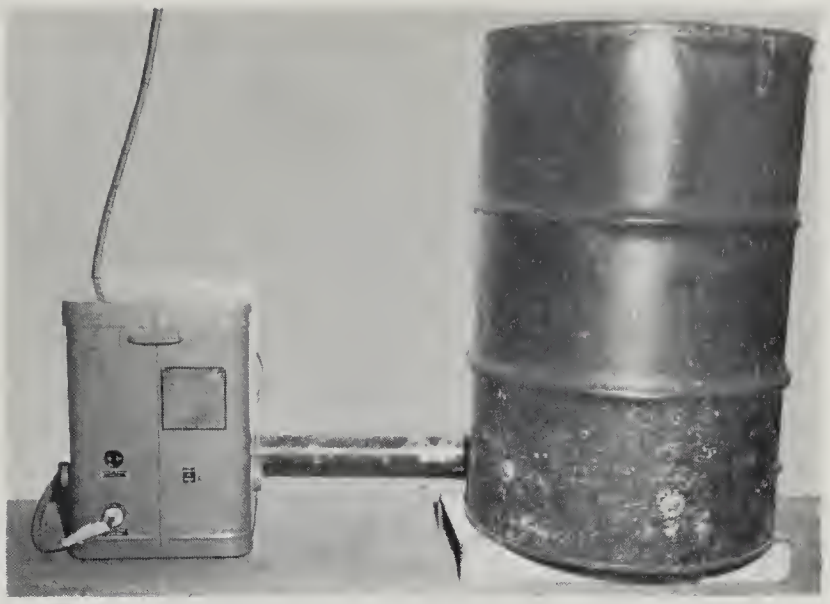

FIGURE 16.—Silica gel drying apparatus for drying small samples of rice.

preliminary trials are tested for at least 3 years in replicated yield trials and are evaluated for disease reaction and cooking quality. When a variety is proved to be superior to commercial varieties, the seed is purified and increased and seed of the new variety is distributed to farmers.

Selection

Selections from introduced or commercial varieties have been an important source of rice varieties in this country. Practically all of the varieties grown in the United States from 1920 to about 1945 were developed by this method.

Jones (*55*) named the breeders who participated in this work from about 1900 to about 1930. Most of these breeders were employees of the U.S. Department of Agriculture. Chambliss and Jenkins (*25*) listed and described six varieties that were developed by selection. These are Acadia, Delitus, Evangeline, Salvo, Tokalon, and Vintula. These six varieties were not grown extensively but probably were important for a few years in local areas in Louisiana. Ten other varieties developed by selection and listed and briefly described by Jones (*55*) are Blue Rose, Caloro, Colusa, Early Prolific, Edith, Fortuna, Lady Wright, Nira, Rexoro, and Shoemed. Other varieties developed by pure line selection are Conway (*29*), Sunbonnet (*42*), Bluebonnet 50 (*57*), and Iola, Latex, Mortgage Lifter, Storm Proof, and Zenith (*58*). Other selections have been made by farmers and grown locally for a few years.

Selection is a relatively easy method for breeding rice, but it takes many years to develop a variety by this method. The procedure is to select a large number of plants or panicles from a variety that consists of diverse types. These selections are sown in single-row plots and carefully observed for the principal characters. If a selection from the progeny of a hybrid is segregating, desirable plants or panicles are selected and sown in single-row plots the second year. When promising lines are breeding true to type, they are tested in replicated yield trials in the same manner as introductions. When a selection is proved to be outstanding, it is named, the seed supply is purified and increased, and it is released for commercial production.

Most of the varieties developed by the selection method have been replaced by newer varieties, although there are a few notable exceptions. In 1963, Bluebonnet 50 was the leading variety in the South, and Rexoro was grown rather widely in Louisiana and Texas. Caloro was the leading variety in California, and Colusa also was widely grown in that State.

Hybridization

Varieties developed by the selection method were a vast improvement over the varieties they replaced, but varieties developed by this method did not have all the desired characters. Since about 1922 rice breeders in the United States have used the hybridization method of rice breeding, and hundreds of crosses have been made.

Three systems are followed in the hybridization method of breeding rice. These are: (1) Two varieties are crossed and the progeny grown in pedigreed rows or bulk plots until pure lines are selected; (2) the backcrossing system in which two varieties are crossed and the F_1 plants crossed to one of these varieties and repeated for four or five times; and (3) the multiple crossing system in which four or eight varieties are crossed in pairs, followed by crossing the F_1 plants from the different combinations so that after two or three rounds of crossing, F_1 plants are obtained that contain some genes from each of the parent

varieties, These systems may also be modified in various ways.

Crossing Techniques.—The two basic techniques used for making rice crosses are the clipping and the hot water method. There are several modifications of the clipping method but in each case a part of the lemma and palea is removed. In the hot water method the panicle is emersed in hot water.

An example of the clipping technique that has been widely used was described by Jones (*55*) and may be summarized as follows: In the morning before the rice begins to bloom, or in the afternoon after the daily blooming period has passed, all except 10 to 20 spikelets are removed from the female panicle. The upper part of the lemma and palea of the remaining spikelets are clipped off at about a 45° angle. This removes about half of the lemma but only the tip or none of the palea so the anthers can be easily removed with fine-pointed forceps. The emasculated panicle then is tagged and covered with a glassine bag. The same day or the next day between 9:00 a.m. and 2:00 p.m., depending somewhat upon the weather, the emasculated panicles are pollinated. Plants of the variety to be used as the male parent are examined, and a panicle that has spikelets about to bloom is taken. A spikelet that has the anthers pushing up toward the tip of the floret is opened, and an anther or two are placed in the emasculated flower. Usually the anthers are broken open and the pollen is dusted on the stigma. This process is repeated until all flowers have been pollinated. After pollination, the panicle is again enclosed in the bag and the designation of the parents and the date of pollination are written on the tag.

A modification of the clipping method has been used at the Rice-Pasture Research and Extension Center, Beaumont, Tex. In this method, the tips of the lemma and palea are clipped off at right angles to the longitudinal axis of the spikelet. The anthers then are removed by vaccum, by means of a fine glass nozzle connected to a vacuum pump that is driven by an electric motor operating from a storage battery. Emasculating is done in the early morning or in the late afternoon; and pollinating, bagging, and tagging are completed in the same manner as in the clipping method described by Jones (*55*).

Another technique that has been used for crossing rice is a modification of a method developed for wheat and barley (*85*). In this method, the lemma and palea are clipped at right angles to the longitudinal axis of the spikelet at a point just above the tip of the stigma. This cuts the anthers, and it is not necessary to remove them. The florets are clipped early in the morning or in the afternoon, and then the emasculated panicle is covered with a fairly large glassine bag. Later that day or the next day, pollen from a male panicle that has many florets just starting to bloom is dusted on the stigmas of the emasculated panicle. Before pollination the bottom of the inverted bag on the emasculated panicle is slit so that it can be spread open and can serve more or less as a funnel while the pollen is being applied. The bag then can be closed, folded over, and fastened with a paper clip. The pollinated panicle is then tagged to show the designation of the parents and the date of pollination.

As a result of the elevated temperature within the bag, seed set may be poor in crosses made by clipping the floret. In an effort to devise a technique for making a cross that would not require bagging the female panicles, Jodon (*39*) developed the hot-water method for emasculating rice flowers. In this method, the female panicle is immersed in water at a temperature of 40° to 44° C. for 10 minutes in the morning before any of the florets have opened. This critical temperature renders the pollen grains ineffective but does not prevent the normal functioning of the female portion of the rice florets. Within a few minutes after the panicle is removed from the warm water, the florets that would have bloomed later that day open. These florets can be pollinated in the same manner as in the clipping method. Spikelets that already have been pollinated and spikelets that do not open are clipped off. Spikelets at the base of the panicle usually are immature and can be left to produce mother seed. It may not be necessary to bag the panicle, because the lemma and palea usually close in about 45 minutes. Thus, they usually are closed before other plants start to shed pollen. The pollinated panicle then is tagged to show the designation of the parents and the date of pollination.

Single Crosses.—The crossed seeds are planted in a greenhouse in the fall after the cross is made or in the field the next spring. When the F_1 plants are grown in the greenhouse during the winter, a year is saved because the F_2 population can be grown in the field the year after the cross is made.

Usually several F_1 plants are grown to assure that typical parental strains were used in making the crosses. The cross should be made so that the F_1 plant can be distinguished from the female parent variety. For example, when pubescent × nonpubescent varieties are crossed, the nonpubescent variety should be used as the female parent. F_1 plants should be propagated vegetatively until it is known that they are not needed for additional seed production or other purposes. Vegetative propagation of F_1 plants is also helpful in obtaining increased quantities of F_2 seeds.

Seeds from the F_1 plants are spaced thinly or space sown in rows 12 inches or farther apart. When space sown, seeds are placed 3 to 6 inches

apart in the row, so the F_2 plants can be examined individually for plant characters and disease reaction. A further advantage of space seeding F_2 populations is that all the seed produced by a selected F_2 plant can be harvested and used for (1) preliminary quality tests on milled samples (5 to 10 grams), (2) growing at different locations or dates of seeding to obtain information on reaction to diseases and to photoperiod and other environmental influences, and (3) seedling tests in greenhouse or growth chamber for blast reaction and seedling hardiness. In important crosses where known genetic variables can be identified, early-generation testing has proved very effective.

The rice-breeding procedures used in the F_3 and subsequent generations usually are governed by particular circumstances such as available personnel, physical facilities, financial considerations, urgency of a particular development, number of characters involved, and mode of inheritance.

The pedigree system has been more widely used than other systems of handling hybrid progenies, although modifications of the pedigree and bulk systems are frequently followed.

In the pedigree system, the F_2 plants are carefully examined in the field and laboratory. The selections that appear to be satisfactory for all characters studied are sown in individual rows (8 to 16 feet long and 12 inches apart) the next spring. Seeds are spaced thinly in rows. Space seeding is seldom used for F_3 and later generations.

When facilities and circumstances permit, a system of multiple screening of selections may be used. Desirable plants are saved from the F_2 progenies in the field, and each plant is threshed individually. A small portion of the grain of each is milled, and plants having chalky kernels are discarded. Milled samples from the remaining plants are tested in the laboratory to determine cooking quality. Undesirable plants are eliminated, and the seeds of each of those remaining after the double screening are divided into three parts. One part (about 25 seeds) of each is tested for reaction to hoja blanca under controlled conditions. Another part is seeded late in the field under conditions believed to be favorable for the development of blast. The third part is seeded in the breeding nursery to observe agronomic characters and to provide seed for further testing of lines surviving the multiple screening. This screening method eliminates many undesirable lines in the F_3 generation.

The F_3 lines are carefully examined throughout the growing season and usually from 6 to 15 panicles are selected from lines that have the desired plant and grain type and that appear to be resistant to diseases. The quantity of seed from each panicle is seldom sufficient for seeding at more than one or two locations. Small samples for quality tests and a few seeds for disease nurseries may be obtained by bulking part of the seed from each of the 6 to 15 panicles harvested from a given F_3 line. The remaining panicles in a line may be harvested in bulk to provide additional seed for testing the line for resistance to straighthead, hoja blanca, and blast; and for seedling hardiness, grain quality, or other characters. The F_4 lines are handled in much the same manner as the F_3 lines. Usually from 3 to 6 selected panicles of each line are sown in panicle-row plots the following year.

Early-generation testing is continued until it is reasonably certain that the lines are no longer segregating for the characters under study. From 10 to 15 panicles are selected from nonsegregating rows, and then the rows are harvested and threshed in bulk. Part of the seed from the harvested rows is used for more extensive laboratory grain quality tests.

Lines that have suitable grain type are then tested in a preliminary yield trial. Some lines may be discarded because of lack of vigor, weak straw, disease susceptibility, undesirable cooking quality, or other undesirable characters. Lines that are heterozygous for one or more characters but otherwise appear to be desirable are replaced by pedigree sublines selected from later generation panicle rows. True breeding lines usually can be isolated in six to eight generations. The true breeding lines then are tested for at least 3 years to determine yielding ability, disease resistance, time of maturity, plant height, stiffness of straw, and cold tolerance, and to check thoroughly milling, processing, cooking, and other characters. Lines that prove to be superior to existing varieties in one or more characters are then named, the seed is purified and increased, and the seed of the new variety is distributed to growers.

The bulk system has been used to a limited extent, particularly where time and space were limiting factors. True breeding lines usually can be obtained in fewer generations when the pedigree method is used.

In the bulk system of breeding, the F_1 plants are grown and the F_2 populations are sown in the same manner as in the pedigree method. The F_2 population is harvested and threshed in bulk. Progenies from each cross may be kept separate or the progenies from several crosses with similar parentage may be combined. From 10 to 25 rod rows are grown in F_3. They are harvested and threshed in bulk and sown on a similar size plot the next year. This procedure is followed for each succeeding generation until F_6 or F_7. In bulk-hybrid populations, special care should be taken to be sure that desirable plant types are not being eliminated through natural selection. For

example, tall and profuse-tillering types tend to eliminate short types (*6*).

The bulk system often is modified in various ways. For example, if there is a differential plant reaction to a natural or artifically induced infection of a serious disease, a bulk is made up by selecting the resistant plants. Plants that make up the bulk are sometimes tested for processing and cooking quality. Where the parents differ in grain type, panicles having the desired grain types are selected in bulk or the bulked seed is graded on the basis of length and width, and the desired grain type is saved. This operation might be repeated for several generations. When unfavorable weather or a shortage of help makes selections in the field impossible, a composite may be harvested and panicles selected in the laboratory. In this case, the grain from selected plants is combined for seeding the bulk plot the next year.

In California, progenies from each cross are sometimes grown in small, water-seeded plots where the material is seeded under conditions similar to those of the commercial ricefields. This method aids the breeder in selecting plants that emerge readily through deep water. Also, when rice is water seeded, some varieties do not develop sufficient roots, and plants may tend to lean as the grain matures. Thus, when rice is water seeded in breeding studies, plants may be evaluated for resistance to this type of lodging.

Each year the material may be subjected to natural selection pressures in an attempt to eliminate undesirable types. Examples of natural selection pressures are: Harvesting before late plants are mature if short-season types are desired; seeding under conditions where straighthead is likely to occur; or inoculating with *Aphelenchoides besseyi* Christie (sometimes called *A. oryzae* Yokoo) to eliminate plants susceptible to white tip. After six or seven generations, a large number of plants or panicles are selected, preferably from a space-planted population. The plants are carefully examined and only those that appear to have strong straw, disease resistance, and good grain type are selected. Seeds of the selections are then examined in the laboratory much the same as seeds from F_2 plants are examined, and those that appear to have the desired kernel characters are sown in single-row plots the next year. The selections are then handled in the same manner as advanced-generation selections obtained by the pedigree method.

Many rice varieties have been developed in the United States by the hybridization method. Varieties that were named and released are as follows: Arkrose, Belle Patna, Bluebonnet, Calady, Century Patna 231, Cody, Delrex, Gulfrose, Improved Bluebonnet, Kamrose, Lacrosse, Magnolia, Missouri R–500, Nato, Northrose, Nova, Prelude, R–D, Rexark, R–N, Saturn, Texas Patna, Toro, TP 49, and Vegold. Many of these varieties were not in commercial production in 1963, although varieties developed from crosses comprised about 85 percent of the United States acreage that year.

Backcross.—The backcross system or a modification of the typical backcross system is successfully used to some extent in rice breeding in the United States. As with other small grains, this system is used when it is desired to transfer one gene or a small number of genes to a fairly well-adapted variety. This system has not been used as widely with rice as with other small grains. Commercial rice production methods in the United States have undergone periodic changes (combine harvesting, increased fertilizer use, new herbicides) that have resulted in rather drastic changes in plant-type requirements. Because rice breeders have had to search for divergent types, the use of standard varieties as recurrent parents in a formal backcross program has been prevented. As production methods become more stable and satisfactory plant types are developed, and as rice breeding progresses in the United States, the backcross method may be used more generally. Adair, Miller, and Beachell (*7*) described briefly the development of hoja blanca resistant, long-grain types by backcrossing.

Calrose (*57*), a medium-grain variety, was developed by this method of breeding.

Multiple Cross.—Multiple crossing has been used very little by rice breeders in the United States. Several varieties have been developed from rather complex crosses, but none of these were selected from a population obtained from systematically crossing four or more varieties.

Irradiation

Irradiation breeding has been employed in the United States. Several mutants that may be useful in breeding programs have been obtained in this manner, but no varieties have been developed.

Breeding for Agronomic Characters

Rice often is seeded early in the spring when the soil temperature is low, or it may be sown in water that is below the optimum temperature. Thus, seedling vigor is an important character of rice varieties, and it is desirable to study seedling vigor and cold tolerance concurrently and to combine the two characters in a rice variety.

At optimum temperatures, indica varieties generally grow faster in the seedling stage than do japonica varieties. However, some of the japonica varieties are more tolerant to low temperatures, and seedlings of these cold-tolerant japonica varieties may grow and develop faster than seedlings of indica varieties when the temperature of the soil or water is low.

Vigor and cold tolerance of seedlings are studied under controlled conditions (*68*) and in the field. In the controlled studies, the seeds are sown in water and the temperature is maintained at 60° F. The length of longest leaf at about 30 days is the criterion used to judge tolerance and vigor. The varieties and lines that are vigorous and cold tolerant under controlled conditions are tested in the field. Field experiments are conducted by water seeding in fields where the irrigation water is cold, or by drill seeding early in the spring. Because variability is high under field conditions, results for a particular experiment are not always dependable. But over a period of years, useful information can be obtained on the performance of varieties under these adverse conditions.

Varieties also differ in their response to low temperatures during the flowering stage. This character of rice varieties and breeding lines is studied by seeding late, so that pollen development and flowering occur when the temperatures are low. In Texas, when temperatures are below the optimum in October when rice is flowering, hardy varieties, such as Caloro, continue to develop; whereas cold-sensitive varieties, such as Bluebonnet 50 and Century Patna 231, may not produce seed.

Rice varieties also vary in response to high concentration of salts in the irrigation water and in the soil. Varietal response to salt was studied at Stuttgart, Ark., and Beaumont, Tex. At Stuttgart, on soils with a high salt content, Arkrose produced 4,180 pounds per acre and Bluebonnet 50 produced 3,172 pounds. On soils with lower concentration of salts, Arkrose produced 4,531 pounds per acre and Bluebonnet 50 produced 3,838 pounds. At Beaumont, with a concentration of sodium chloride of about 2,500 parts per million in the irrigation water, Caloro produced 1,789 pounds of grain per acre, whereas Toro produced only 842 pounds. When no salt was added to the irrigation water, Caloro produced 4,820 pounds per acre and Toro 3,716 pounds.

The Beaumont studies were conducted in 1/10-acre blocks of Beaumont clay soil. Approximately 2,500 parts per million of salt was maintained in the irrigation water by adding sodium chloride. Frequent additions of salt were needed because of dilution from rains and soil moisture exchange. As much as 15,000 pounds of salt per acre was used during the 70- to 80-day test. Salt was first added to the irrigation water when the rice plants were about 45 days old.

Under these conditions an attempt was made to grow breeding lines in single-panicle rows as well as to conduct yield tests in replicated nursery plots. Widely different responses occurred because of weather conditions during blooming and immediately thereafter. When blooming occurred during periods of cloudy weather and moderate temperatures, practically all lines showed good seed sets. When temperatures were high and humidity was low, practically all lines showed poor seed sets. After several years, the test was abandoned because it required a great amount of time and effort and provided little information.

Varieties that produce maximum yields must have relatively short and sturdy straw, so that the rice does not lodge before harvest (fig. 17). Japonica varieties have smaller and shorter culms and shorter, narrower, and darker green leaves than do most indica varieties. Although there are exceptions, japonica varieties generally produce higher yields than do indica varieties; this indicates that morphologic characters might be associated with grain yield. The japonica varieties have tough but willowy stems. The less willowy straw character of the indica varieties is preferred since this type is less likely to lodge.

For several years, rice breeders have been searching for plants with short, slender stems; with erect, relatively narrow, dark-green leaves of intermediate length; and with low percentages of sterility at high rates of nitrogen fertilization. Strains approaching this description have been selected from crosses between a Taiwan variety, Tainan-iku No. 487 (P.I. 215,936),[3] and United States varieties. Ten short-stature selections from these crosses were grown in a variety-fertilizer test in 1961. They averaged 4,224 pounds of rough rice per acre at the 160-pound nitrogen rate and 3,367 pounds at the 80-pound rate. The highest yielding strain yielded 5,658 pounds at the 160-pound rate and 4,022 pounds at the 80-pound rate, compared with Bluebonnet 50, an indica type variety, which yielded 3,448 and

FIGURE 17.—A field of Caloro rice showing serious lodging.

[3] P.I. refers to the accession number assigned to foreign introductions by the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture.

2,916 pounds, respectively, at the two rates of nitrogen fertilization.

In an effort to find short-stature types possessing superior yielding capacity, varieties that combine extremely narrow and erect leaves and small stems have been crossed.

Short-strawed plants have been found in hybrid and irradiated populations, as mutations from varieties, and in introductions from foreign countries. In Arkansas, naturally occurring dwarf types were saved from C.I. 9187,[4] a high-yielding, lodging-resistant, early long-grain experimental variety that has short straw and narrow leaves. Crosses were made with Bluebonnet types to improve milling quality, and dwarf and semidwarf types were saved for testing.

The short-stature types showed considerable variation in plant height because of the degree of internode elongation. Club and grassy dwarfs seldom grow more than 12 to 18 inches tall. Since grains are shortened and frequently are otherwise distorted, they are of no economic value. Some intermediate-height, dwarf-type lines exhibit varying degrees of grain distortion. Other intermediate-height, dwarf-type lines appear to produce grains of normal size and shape.

All of the dwarf-type plants examined appeared to have the normal number of nodes. The reduced height was governed by the extent of internode elongation, including the peduncle (internode just below panicle). In all but one dwarf-type selections examined, all internodes of the stem, including the peduncle, showed reduced elongation when compared with normal height plants. An exception to this elongation pattern was observed in a dwarf plant selected at Beaumont, Tex., in 1955, from an irradiated population of Century Patna 231. The panicles of this selection were normal in length and floret number, and the peduncles were of about normal length. The lower internodes showed only minor elongation; this resulted in an extremely short and sturdy plant.

The grains of the dwarf were of normal length but appeared to be slightly tapered. This dwarf was crossed with normal Bluebonnet 50, Century Patna 231, Rexoro, and Texas Patna. Dwarf-type selections resembling the original strain were recovered in about a 3 normal:1 dwarf-type ratio in all crosses. The original and the dwarf-type selections from the crosses were tested in yield experiments and invariably showed about 15- to 20-percent lower yields than did normal strains. All the dwarf-type strains showed considerably more sterility than did the normal strains, which was probably responsible for the reduced yields. The cause of the increased sterility was not determined. This promising dwarf type will be studied further.

Generally a high rate of nitrogen fertilizer is applied to rice-breeding nurseries to select types that respond to fertilizer and that resist lodging. When pure lines are isolated, they are then tested at two rates of nitrogen fertilization. Usually a randomized, split-plot design is used with varieties as the main plots and with nitrogen rates as subplots (fig. 18).

At Stuttgart, Ark., a continuing experiment designed cooperatively by the agronomist, the plant breeder, and the plant pathologist has been established to compare outstanding experimental varieties with commercial varieties they might be expected to replace. Varieties are tested in maturity groups and receive nitrogen fertilizer at a number of rates and times. The varieties are checked closely for grain yields and disease reaction, lodging, and other characters in the field. Milling yields and chalkiness of the grain and kernels resulting from the various treatments are also checked. To develop a satisfactory nitrogen fertilization program for each variety so that it will give consistently high grain yields with a minimum of lodging and disease, possible new varieties are tested 2 or 3 years as part of a final evaluation before their release.

In fertilizer-variety tests at Stuttgart, Ark., C.I. 9434, a very short-season, experimental long-

FIGURE 18.—C.I. 9446 fertilized at two rates: *Left*, 200 pounds of nitrogen per acre produced a yield of 5,707 pounds of rice per acre; *right*, 40 pounds of nitrogen per acre produced 3,942 pounds of rice per acre.

[4] C.I. refers to the accession number used in the Cereal Crops Research Branch, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture.

grain variety, produced 5,992 pounds of grain per acre compared with 5,839 pounds produced by Bluebonnet 50. In both tests the treatment included 200 pounds of nitrogen per acre, but C.I. 9434 produced this relatively high grain yield in 45 days less time than did Bluebonnet 50; and the straw of C.I. 9434 was 14 inches shorter.

The results from these experiments indicate that it will be possible to develop short-strawed, nonlodging varieties that respond to high rates of fertilizer. Notes on breeding lines and strains in yield tests recorded about 30 and 60 days after seeding and at maturity provide valuable information on plant type. By using symbols, brief notes are obtained on (1) habit of growth of leaves (erect to spreading); (2) color of leaves (light to dark green); (3) leaf width (narrow to wide); (4) plant or seedling height (short to tall); and (5) degree of tillering (low to high). Calculating sterility percentage by counting the number of sterile and fertile florets on selected panicles of breeding lines appears to have merit.

The grain yield of breeding lines and experimental varieties is determined by using replicated nursery plots. For comparison, standard varieties are included in each trial. The experimental design is a complete randomized block, usually with four replications. The plots are about 1 rod (5 meters) long and three or four rows wide. Usually the rows are spaced 9 inches apart in the 4-row plot or 12 inches apart in the 3-row plot. The plots are trimmed to a uniform length before harvesting. For yield determination, the center row is harvested in the 3-row plot, and the two interior rows are harvested in the 4-row plot. One or both of the border rows may be harvested in order to have a larger sample for milling and cooking tests.

An alternate method is the use of 4-row plots usually 15 or 16 feet long with a 12-inch spacing between rows. An 8-foot segment from the two center rows is harvested. By careful harvesting, the remainder of the plot is left standing for later observations and for collection of panicle samples.

In California, where the rice on all farm fields is sown broadcast in the water, the method used for testing varieties is somewhat different. The rice is sown in the water by hand.

The design used for preliminary trials is a complete randomized block with three or four replications. The individual plots are a single row, 12 to 16 feet long, with the rows spaced about 24 inches apart. The preliminary trial gives information on the ability of the variety to emerge through the water, straw strength, and other characters. The best varieties then are tested in randomized, quadruplicated plots large enough to be harvested with a small combine.

Time of maturity (length of growing season) is an important consideration in the breeding program. Although early and very early types have gained favor in recent years, a complete range of maturity types is maintained.

Partial dormancy in rice is desirable, so that rice does not germinate if rain and humid weather occurs at harvesttime or if plants are badly lodged. Seed of nondormant varieties will germinate before cutting if there is a prolonged period of rain after the grain is ripe. It sometimes is desirable to break dormancy of seeds soon after harvest. This is necessary in the case of crossed seeds to be planted in the greenhouse in the winter or other breeding material to be grown during the off season in another region. This can be done by treating in a 0.10- to 0.05-percent solution of sodium hypochlorite for 24 hours or by heating in shallow, open containers for 3 to 5 days at 47° to 50° C.

Rice varieties in the United States are divided by grain size and shape into three types. These are short- (Pearl), medium-, and long-grain types. The more slender, long-grain varieties are sometimes considered as a fourth type. Examples of each type are Caloro, Nato, Bluebonnet 50, and Rexoro, respectively. The grain type can be visually classified; but for more critical comparisons of varieties and for classification, more exact measurements are needed. At the Cooperative Rice Quality Laboratory at Beaumont, Tex., the various grain types are characterized objectively according to length, width, length/width ratio, thickness, and grain weight. Dimensions of rough (paddy), brown, and milled (head) rice grains are measured and reported in accordance with the following definitions:

(1) Length of awnless rough rice is the straight-line distance (millimeter) from the point of disarticulation of the grain, which is below the outer glumes, to the tip of the apiculus (fig. 19, *B*). For awned rough rice the tip of the lemma is the reference point. Length for brown and milled rice is the distance between the most distant tips of the kernel, including the embryo of the brown rice kernel (fig. 19, *A*).

(2) Width (dorsiventral diameter) for rough rice is the distance (millimeter) across the lemma and palea at the widest point (fig. 19, *B*). Width for brown and milled rice is the distance across the kernel at the widest point (fig. 19, *A*).

(3) Thickness (lateral diameter) for rough rice is the distance (millimeter) from one outside surface of the lemma to its opposite at the thickest point (fig. 19, *D*). Thickness for brown and milled rice is the distance from one side of the kernel to its opposite side at the thickest point (fig. 19, *C*).

By modifying a photographic enlarger, a device was built for measuring the length and width of rice (fig. 20). The enlarger was mounted on a box with three sides that were painted black on

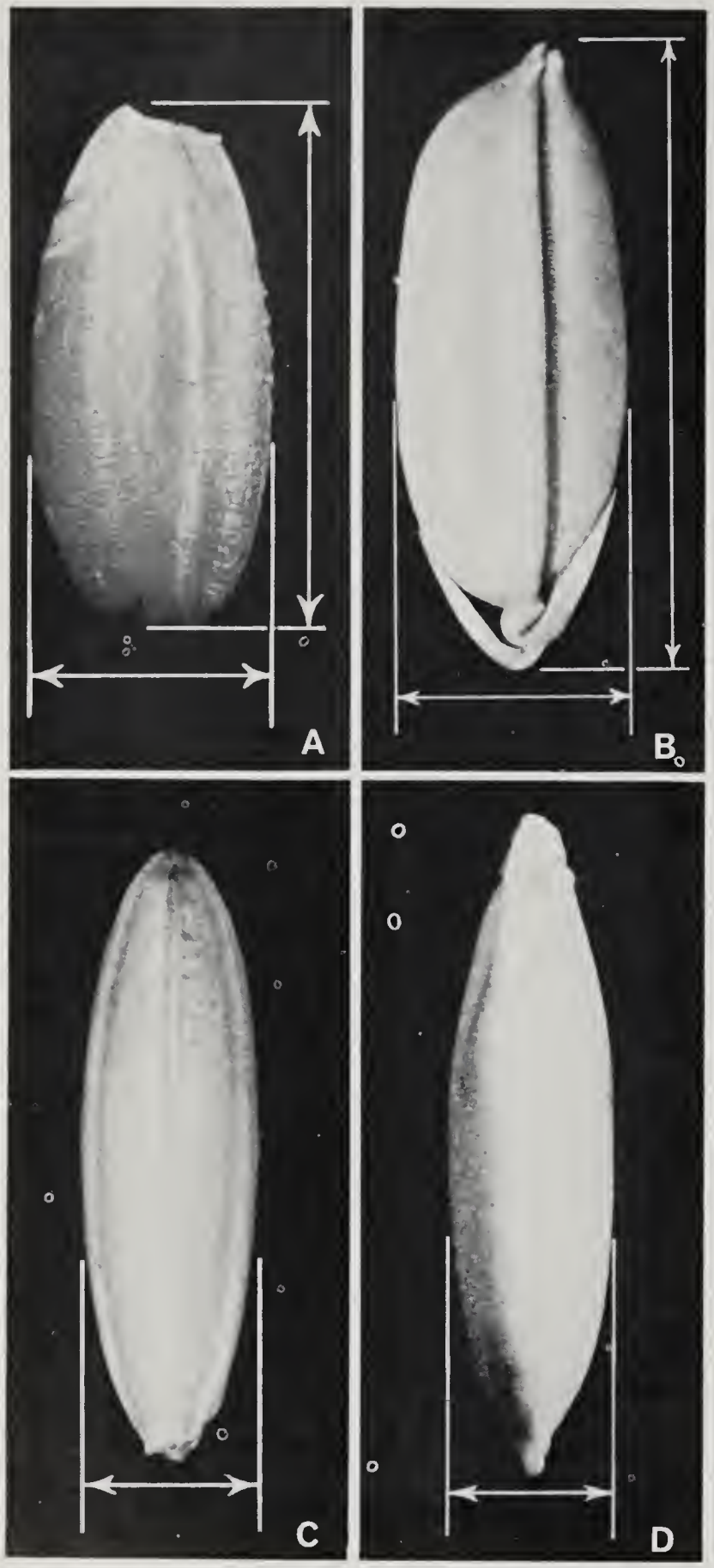

FIGURE 19.—Points from which rice grain and kernel measurement should be made.

the inside. A black cloth was placed over the open side of the box to exclude most of the light, so that a distinct image of the rice grain would appear on the white grid. Minute adjustments were made to obtain a magnification of exactly 10 times.

FIGURE 20.—Device for measuring rice grains and kernels.

The light source was a 6- or 12-volt cold, sealed-beam, automobile spotlight. The spotlight had a smooth surface, so that light or shaded areas would not be projected on the grid. Any cold light source of similar intensity should be satisfactory.

A 50-mm.F/4.5 liminized lens was used. This lens made it possible for the enlarged image (10×) to be projected on a grid that was less than 24 inches from the lens.

A glass slide that held 10 grains was placed in the light field just above the bellows and the 50-millimeter lens. A millimeter scale was placed on the glass slide. The image of the millimeter scale was magnified 10 times and made possible accurate focusing before use. The adjustable bellows to which the 50-millimeter lens was attached made it possible to obtain a clear-cut image. The enlarged images of the rice grain were measured to obtain the length and width.

The thickness of the rice grain was determined by using a micrometer caliper graduated in millimeters. The micrometer was placed in a small vice attached to a table. A sheet-metal tray at the base of the micrometer, to catch grains dropped during the operation, is useful.

If similar equipment is not available, a random sample of 10 grains or kernels can be placed adjacent on transparent tape in the desired position for the particular measurement, and the total length, width, or thickness can be measured with a fair degree of accuracy by using a transparent ruler.

The length, width, and thickness of milled kernels are determined by measuring 15 whole kernels selected at random from a representative sample. The coefficient of variation for each dimension is calculated for each of 15 kernels to determine the uniformity of size and shape. Size and shape classes for brown kernels are as follows:

Size classification	*Length (Millimeters)*
Extra long (EL)	Over 7.5
Long (L)	6.61 to 7.5
Medium (M)	5.51 to 6.6
Short (S)	Up to 5.5

Shape classification	*Length/width ratio*
Slender	Over 3
Medium	2.1 to 3
Bold	Up to 2.1

The average length, length/width ratio, thickness, and 100-grain weight of rough, brown, and milled (head) rice for each of 18 varieties are tabulated in table 6.

Testing for Milling, Cooking, and Processing Qualities

The determination of milling, cooking, and processing qualities of hybrid progenies, breeding lines, and new varieties is an essential part of the rice-breeding program. New varieties that are released for commercial production must meet established standards for these qualities. Certain cooking and processing qualities are historically associated with specific grain types. For example, most of the long-grain varieties grown in the United States cook dry and flaky, and some are used for specific processed products. The short- and medium-grain varieties grown in the United States are more moist when cooked than are the long-grain varieties and are used for specific processed products such as dry cereals. Thus, it is desirable that a new variety have the same cooking and processing qualities as the variety it replaces.

Milling Quality

The objective of rice milling is the removal of hulls, bran, and germ with a minimum breakage of the endosperm. The milling process generally consists of four fundamental operations: (1) Cleaning the field-run rough rice to remove such things as mud lumps, rice stems and leaves, weed seeds and stems, and other foreign matter; (2) shelling the cleaned rice to remove the hulls; (3) scouring the brown rice to remove the coarse outer layers of bran, white inner-bran, aleurone layers, and germ; and (4) grading the mixture of whole and broken milled kernels according to size classes known as head rice (whole-grain milled kernels), second head (larger pieces of broken milled kernels), screenings (smaller pieces of broken milled kernels), and brewers rice (very small pieces of broken milled kernels) (*7*, *16*). In modern rice mills, all operations in the rice-milling process are performed mechanically with a minimum amount of manual labor, including the transfer of rice from one machine to another for the next series of operations. Fraps (*30*), Geddes (*31*, *pp. 2043–2051*), Kik and Williams (*62*), Wayne (*84*), and, more recently, Kester (*61*) have described the commercial milling of rice as practiced in the United States. Additional information describing rice milling and processing equipment has been published by the Food and Agriculture Organization of the United Nations (*9*, *24*).

The milling quality of rice is based on the yield of head rice obtained, since it is usually the milled product of the greatest monetary value. Yields of head rice vary widely, depending on variety, grain type, cultural methods and other environmental factors, and the drying, storing, and milling conditions. The yield of total milled kernels (head rice and all sizes of broken kernels) is important, too, and this yield is influenced by the proportion of hulls and the amount of fine particles of broken kernels unavoidably included in the bran fraction during the milling process.

In rice-breeding programs, rigid laboratory milling tests are required to insure that any new variety released will consistently produce high yields of head rice and total milled rice. At the

TABLE 6.—*Grain characters for 18 rice varieties grown in Uniform Yield Nurseries in Arkansas and Texas, 1959–61*

[Values are averages and are for first cutting only]

Grain type and variety	Grain form [1]	Grain characters			
		Length	Ratio L/W	Thickness	100-grain weight
		Millimeters		*Millimeters*	*Grams*
Short-grain:					
Caloro	Rough	7.3	2.0:1	2.3	2.8
	Brown	5.4	1.7:1	2.1	2.3
	Milled	4.9	1.8:1	2.0	2.2
Cody	Rough	7.1	1.9:1	2.5	2.8
	Brown	5.4	1.7:1	2.1	2.3
	Milled	5.0	1.7:1	2.0	2.2
Colusa	Rough	7.2	1.9:1	2.3	2.8
	Brown	5.4	1.7:1	2.0	2.3
	Milled	5.0	1.8:1	1.9	2.2
Medium grain:					
Arkrose	Rough	8.4	2.6:1	2.2	3.1
	Brown	6.3	2.3:1	1.9	2.4
	Milled	5.8	2.2:1	1.8	2.2
Calrose	Rough	7.8	2.4:1	2.1	2.5
	Brown	5.9	2.2:1	1.8	2.0
	Milled	5.6	2.3:1	1.8	1.9
Gulfrose	Rough	8.0	2.5:1	2.0	2.5
	Brown	6.3	2.3:1	1.8	2.0
	Milled	5.8	2.3:1	1.7	1.9
Magnolia	Rough	8.3	2.5:1	2.1	2.6
	Brown	6.3	2.3:1	1.8	2.1
	Milled	5.9	2.3:1	1.7	2.0
Nato	Rough	7.3	2.4:1	2.0	2.1
	Brown	5.8	2.2:1	1.7	1.7
	Milled	5.3	2.2:1	1.6	1.6
Northrose	Rough	7.7	2.4:1	2.1	2.4
	Brown	5.8	2.1:1	1.9	1.9
	Milled	5.4	2.2:1	1.7	1.8
Zenith	Rough	7.8	2.4:1	2.0	2.3
	Brown	6.0	2.3:1	1.7	1.8
	Milled	5.7	2.3:1	1.6	1.7
Long-grain:					
Belle Patna	Rough	8.7	3.7:1	1.8	2.1
	Brown	6.8	3.4:1	1.7	1.7
	Milled	6.5	3.4:1	1.6	1.6
Bluebonnet 50	Rough	9.6	3.8:1	1.9	2.5
	Brown	7.2	3.4:1	1.7	2.0
	Milled	6.8	3.4:1	1.6	1.8
Century Patna 231	Rough	9.1	3.9:1	1.8	2.1
	Brown	7.0	3.4:1	1.6	1.6
	Milled	6.5	3.4:1	1.6	1.5
Rexoro	Rough	8.8	3.9:1	1.7	2.1
	Brown	7.1	3.6:1	1.6	1.7
	Milled	6.5	3.5:1	1.5	1.5
Sunbonnet	Rough	8.9	3.6:1	2.0	2.4
	Brown	7.2	3.3:1	1.8	1.9
	Milled	6.7	3.3:1	1.6	1.8
Texas Patna	Rough	9.1	4.0:1	1.7	2.0
	Brown	7.1	3.6:1	1.5	1.6
	Milled	6.6	3.6:1	1.5	1.5
Toro	Rough	9.0	3.8:1	1.9	2.2
	Brown	7.1	3.4:1	1.7	1.7
	Milled	6.5	3.3:1	1.5	1.6
TP 49	Rough	9.4	4.0:1	1.8	2.2
	Brown	7.3	3.7:1	1.6	1.8
	Milled	6.7	3.6:1	1.6	1.7

[1] Rough = unhulled grain; brown = grain with hull removed; milled = whole grain milled kernels with hull, bran, and germ removed.

Cooperative Rice Quality Laboratory at Beaumont, Tex., three methods are available for estimating the milling quality of rice varieties and selections. The method used depends on the amount of rice available for testing. The official grading method for determining the milling quality of rough rice by United States standards, described by Smith (*78*, *79*, *80*, *81*) and adapted to laboratory conditions, gives the breeder comparative information regarding milling quality of the more advanced selections grown in larger plots. The method requires 1,000 grams of rough rice for each determination.

A modification of the official method requires only a 125-gram sample (*19*) to estimate the milling quality of rice and enables the breeder to check milling quality at very early stages of selection. The samples of rough rice are sealed in glass jars and kept at room temperature for at least 24 hours to bring the moisture content to equilibrium before the rice is milled. The moisture content is determined, a 125-gram sample of the rice is hulled in a McGill sheller, and the brown rice is weighed. The weight of the hulls is determined by subtracting the weight of the brown rice from the weight of the rough rice.

The brown rice sample is milled in a small McGill miller for 30 seconds, using a 14-pound weight over a steel plate that covers the rice. The sample is immediately milled a second time for 30 seconds, using a 4-pound weight. This second milling gives a high polish to the rice kernels but causes little additional breakage. The milled kernels are sealed in a glass jar to prevent unnecessary breaking due to rapid or uneven cooling. The bran is screened through a 20 × 20 mesh wire screen to recover the small, broken kernels that passed through the miller screen. The finely broken kernels thus recovered are aspirated and added to the milled kernels. The milled kernels are weighed when the rice has cooled to room temperature. The weight of the bran and polish is the difference between the weight of brown rice and the weight of total milled rice.

The whole kernels are separated from the total milled portion with a sizing device developed by the Grain Division, Consumer and Marketing Service, U.S. Department of Agriculture. This device makes use of two indented plates, with flat-bottom holes, tilted at a slight angle and shaken by an eccentric mechanism. During the shaking motion, the rice travels the length of the top sloping plate and drops onto the bottom sloping plate. Whole kernels drop off the end into a container; broken kernels fall into the indents in the plates. Plates with specific size indents are used for each grain type. Results usually are reported as percentage of hulls, bran, head rice, and total milled kernels.

A method also is available for milling very small samples of rice (*76*). This method can be used to mill the rice from one panicle. The rough rice sample is thoroughly cleaned and hulled in a McGill sheller, and a 5-gram sample is weighed for milling. The weighed sample is put into a test tube with 3 grams of abrasive (40- to 60-mesh fused white aluminum oxide or clean, sharp, white quartz sand). The stoppered test tube is mounted in the test-tube miller, which holds 80 test tubes, and is shaken for 45 minutes at a speed of approximately 390 strokes per minute. The samples then are removed and polished in a small sample polishing machine (*77*). This method of milling small samples not only gives information on the milling quality of individual plant selections but also provides a milled sample to use for preliminary tests of the physical and chemical properties of the kernel.

The average milling yields of hull, bran, total, and head milled kernels for each of 18 varieties grown in the Uniform Yield Nurseries in Arkansas, Louisiana, and Texas from 1958 through 1961 are tabulated in table 7. Estimated yields were determined according to the modified procedure of Beachell and Halick (*19*).

Cooking and Processing Qualities

Rice varieties differ greatly in cooking and processing qualities. Among the domestic varieties the quality of home-cooked rice has been described as varying from very sticky to flaky (*46*). Fully cooked grains of typical United States short- and medium-grain varieties are usually somewhat sticky, relatively firm, and tend to stick together. Typical long-grain varieties usually cook to a flaky state with a minimum of splitting and do not tend to stick together. Other terms used to subjectively describe cooking quality are moist or dry, soft or firm, and mealy or chewy. Since different cultural groups prefer different textures, there is a rather widespread demand for all types for use as home-cooked table rice.

There is also a demand for all types of rice for use in the widely different prepared products. Processors of rice prefer different textures for their various products and also specific qualities adapted to the processes themselves. According to Kester (*61*), a substantial amount of the domestic rice crop is processed into various kinds of prepared foods such as parboiled rice, quick-cooking rice, breakfast cereals, canned rice, canned soups, canned rice and vegetable mixtures, dry soup mixes, enriched baby foods, and frozen dishes. Rice flour is used in various processes, and broken rice is often used in brewing. Typical long-grain varieties are preferred for many parboiled and quick-cooking products, and specific

TABLE 7.—*Milling yields for 18 rice varieties grown in Uniform Yield Nurseries in Arkansas, Louisiana, and Texas, 1958–61*

[Values are averages and are for first cutting only]

Grain type and variety	Milling yields [1]				
	Milled rice			Head rice	
	Hulls average	Bran average	Total average	Average	Range
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Short-grain:					
Caloro	18	9	73	68	58–72
Cody	19	9	72	67	58–71
Colusa	18	9	73	65	42–75
Medium-grain:					
Arkrose	20	9	71	63	33–70
Calrose	19	10	71	69	63–72
Gulfrose	20	10	70	65	58–70
Magnolia	20	9	71	66	63–72
Nato	19	9	72	68	63–73
Northrose	20	12	68	64	59–69
Zenith	20	10	70	64	53–71
Long-grain:					
Belle Patna	19	11	70	60	50–69
Bluebonnet 50	19	11	70	63	52–68
Century Patna 231	21	12	67	62	50–67
Rexoro [2]	19	13	68	52	36–61
Sunbonnet	19	10	71	62	50–71
Texas Patna [2]	19	13	68	58	48–65
Toro	19	10	71	67	60–70
TP 49 [2]	19	11	70	58	52–62

[1] Total milled rice is the head rice and all sizes of broken kernels. Head rice is the whole grain milled kernels.
[2] Grown only in Louisiana and Texas.

long-grain varieties are preferred for certain canned soup products. Medium- and short-grain varieties are more suitable for dry breakfast cereals and for use in baby foods and in brewing. The short-grain types exclusively are used for making puffed rice.

Although in the United States each grain type is generally associated with specific cooking and processing qualities, notable varietal exceptions within each grain type have been reported; and the nontypical cooking and processing quality of these grain-type exceptions in relation to measured differences in some chemical and physical qualities of the rice grain has been discussed (*20*, *33*).

In rice-breeding programs, cooking and processing quality is considered to be an important measure of the suitability of a variety or selection for specific purposes. At the Cooperative Rice Quality Laboratory at Beaumont, Tex., results of specific chemical and physical tests collectively serve as indices of cooking and processing qualities. The results guide the rice breeder in selecting lines that combine the desired cooking and processing qualities and agronomic features. The merit of this type of evaluation has been clearly demonstrated.

Some of the chemical and physical tests are the determination of amylose content (*87*), starch-iodine-blue value (*34*), gelatinization temperature (*33*), type and extent of disintegration of whole milled kernels in contact with dilute alkali (*65*), and amylograph pasting qualities (*33*).

The amylose content of rice, particularly of long-grain types, has recently been associated with cooking quality (*71*, *87*). The investigations of Williams and others (*87*) showed that the long-grain domestic varieties known to cook dry-flaky usually had the highest amylose content; whereas the amylose contents of the short- and medium-grain varieties investigated were somewhat lower. The glutinous (waxy) varieties contain virtually no amylose. The simple, rapid, and somewhat empirical starch-iodine-blue test (*34*) is particularly useful in breeding programs for estimating the relative amylose content of early-generation breeding material.

The gelatinization temperature of rice is believed to be closely related to cooking quality. The amylograph studies (*33*) showed that most short- and medium-grain varieties gelatinized at lower temperatures than did most of the long-grain varieties investigated. These results were confirmed by granule swelling and birefringence

end-point temperature (BEPT) determinations (*32*).

The reaction of milled rice kernels in contact with dilute alkali has been used to classify the cooking quality of rice (*56*, *83*). The type and extent of disintegration of whole milled rice kernels in contact with dilute alkali were reported more recently (*65*). Two distinct reactions were noted: (1) Spreading where the kernels disintegrated into small granules and spreading to several times the original kernel size; and (2) clearing where the starch is solubilized with a loss of opacity. Spreading and clearing were evaluated on a numerical scale from 1 (minimum) to 7 (maximum). A slight-to-moderate reaction was characteristic of most domestic long-grain varieties and a more pronounced reaction was characteristic of most short- and medium-grain varieties. A very high correlation between the alkali reaction and gelatinization temperatures has been observed (*33*).

The pasting quality of several domestic varieties as determined with the amylograph have been described (*33*). In general, amylograph curves of rice varieties were typical of those of other cereal starches, but they showed appreciable differences among the varieties studied. Long-grain varieties with the highest amylose content usually showed the greatest increases in viscosity when cooled to 50° C. Amylograms of most short- and medium-grain varieties generally exhibited relatively shorter gelatinization times.

Notable varietal exceptions within each grain type were observed by Halick and Kelly (*33*). For example, the long-grain varieties Rexark and Toro had amylose contents, gelatinization temperatures, and alkali spreading and clearing reactions similar to those of typical short- and medium-grain varieties. These long-grain varieties are also thought to resemble the typical short- and medium-grain varieties more in cooking quality than they do other long-grain varieties. Of all the varieties tested, Century Patna 231, a long-grain variety, and Early Prolific, a medium-grain variety, had the highest gelatinization temperature and were the most resistant to the action of dilute alkali. In general, these varieties have not been widely accepted for certain types of cooked rice and processed products.

Average values for some of the physical and chemical characters of 18 rice varieties grown in the Uniform Yield Nurseries in Arkansas, Louisiana, and Texas, from 1958 through 1961, are tabulated in table 8. Environmental and other factors influence these qualities to some extent; however, within a limited range, the values are representative of each variety. In the rice-breeding program, characters of new selections are always compared with comparably grown commercial varieties. Some of the physical and chemical characters of the short- and medium-grain varieties listed in table 8 are a relatively low amylose content, a relatively low gelatinization temperature, a very pronounced alkali reaction, and a relatively low viscosity of the cooked paste when cooled to 50° C. The typical long-grain varieties are qualified by a relatively high amylose content, an intermediate gelatinization temperature, a slight-to-moderate alkali reaction, and a maximum increase in viscosity of the cooked paste when cooled to 50° C. Of the typical long-grain types, the late-maturing varieties Rexoro, Texas Patna, and TP 49 consistently had the highest amylose content, the lowest peak viscosity, and a maximum viscosity of the cooked paste when cooled to 50° C. These varieties are preferred for certain canned soup products. The nontypical cooking and processing quality of Century Patna 231 and Toro, both long-grain varieties, has been discussed previously.

Physical and chemical grain quality evaluation tests are invaluable to the plant breeder in developing varieties with specific processing and cooking quality. The specific tests used depend on the quality variables of the particular hybrid population in question and the purpose for which the end product is to be used.

The results of the starch-iodine-blue and the alkali digestion tests enable the plant breeder to classify early-generation hybrid lines as to gelatinization temperature of starch and relative amount of amylose. Promising advanced-generation lines are evaluated from data obtained in analytical tests for amylose and protein content, pasting qualities using an amylograph, and cooking, parboiling, and canning tests. In certain crosses where it is essential to retain a specific pasting quality or parboiling and canning character, it may be necessary to obtain amylograph data on early-generation lines to make certain that the desired qualities are recovered. Such tests are usually conducted on a relatively small number of samples because of the quantities of grain required and the time used in performing the tests. Parboiling and canning tests using 5 to 10 grams of rough rice can be conducted on rather large numbers of samples if necessary, but the cost is relatively high.

The cross Gulfrose × Bluebonnet 50 is an example of how quality tests aid in the rice-breeding program. In this cross, the objective was to develop a long-grain Bluebonnet 50 type possessing the hoja blanca resistance of Gulfrose. Gulfrose ordinarily shows a low gelatinization temperature and relatively low amylose content, whereas Bluebonnet 50 ordinarily shows intermediate gelatinization temperature and relatively high amylose content.

A large number of long-grain types resembling Bluebonnet 50 were saved from the F_2 plant

TABLE 8.—*Physical and chemical characters of milled kernels for 18 rice varieties grown in Uniform Yield Nurseries in Arkansas, Louisiana, and Texas, 1958–61*

[Values are for first cutting only]

Grain type and variety	Physical character (paste viscosity) [1]		Chemical characters			
	Peak	Cooled to 50° C.	Amylose content [2]	Gelatinization temperature [2]	Alkali reaction [3]	
					Spreading	Clearing
	Brabender Units	*Brabender Units*	*Percent*	*° C.*		
Short-grain:						
Caloro	850	690	19	66	7	6
Cody	950	690	17	67	6	6
Colusa	840	690	18	67	6	5
Medium-grain:						
Arkrose	820	660	21	64	7	6
Calrose	960	680	19	65	7	6
Gulfrose	750	660	19	66	6	5
Magnolia	920	700	14	67	6	5
Nato	960	640	16	67	6	5
Northrose	820	630	15	67	6	5
Zenith	860	710	19	66	6	5
Long-grain:						
Belle Patna	820	770	26	70	4	2
Bluebonnet 50	790	730	24	73	4	2
Century Patna 231	950	730	16	77	2	1
Rexoro	600	750	28	69	4	3
Sunbonnet	810	740	26	73	4	2
Texas Patna	630	760	28	71	4	3
Toro	870	740	17	65	7	6
TP 49	690	770	28	69	4	3

[1] Average Uniform Yield Nursery in Texas, 1958–61.
[2] Uniform Yield Nurseries grown only in Arkansas and Texas.
[3] Reaction in 2.0 percent potassium hydroxide solution.

population. A portion of the grain from each plant saved was milled in a test-tube miller. The milled samples were visually examined for grain texture, size, and shape; and alkali digestion and iodine-blue values were determined. Samples showing grains of intermediate gelatinization temperature and relatively high amylose (an iodine-blue value of 25 or below) were saved for hoja blanca testing. In the F_3 plant generation, a bulk made up of 15 or more panicles was again milled, and the quality tests were repeated. The strains that appeared satisfactory agronomically after F_5 or F_6 plant generations were increased for yield testing; and at this stage other quality tests for characters, such as analytical amylose and protein content and pasting viscosity, were made.

Breeding for Disease Resistance

The easiest, most practical, and least expensive way to control rice diseases is to use resistant varieties. Considerable research has been done in the United States on the reaction of rice varieties to the various rice diseases and on developing resistant varieties. Much of this work has been reviewed (*13*, *14*). The symptoms, control measures, and importance of the rice diseases occurring in the United States are given in the section "Rice Diseases," p. 113. Methods used to breed resistant varieties are presented in this section.

Certain basic principles apply to breeding for disease-resistant varieties of a crop. Techniques to create an epiphytotic of the disease and to evaluate and record the response of the plant to the causal organism must be developed. Then the available varieties and breeding lines must be tested to determine sources of resistance to the causal organism. Resistant varieties can then be crossed with varieties possessing other desirable characters, the progenies can be tested, and the resistant lines can be isolated. Where a resistant variety has few attributes other than resistance to the disease under study, it may be used as the donor variety in a backcross program. In order to develop efficient breeding techniques, the mode of inheritance of reaction to causal organisms must be determined.

Blast

Blast, caused by the fungus *Piricularia oryzae* Cav., is an important disease of rice. Much research has been done on it in the United States and in other rice-producing countries. Physiological races of *P. oryzae* that occur in the United States (*64*) make the breeding of resistant varieties more complex than if races did not occur. Genes for resistance to each race that is known to occur in the United States are available, but not all are present in any one variety.

A satisfactory method for inoculating plants (*8*) and a system of rating reaction have been developed (*64*). Many varieties in the World Collection and breeding lines have been tested under controlled conditions for reaction to specific races of *P. oryzae*. Uniform trials have been conducted in the field under a wide range of environmental conditions (*13*). Some studies on the genetics of reaction to *P. oryzae* have been made (*13, 66*), but information is not available on the genetics of reaction to all races.

An accelerated program of testing and breeding rice for resistance to blast in the United States was started in 1959. The initial tests consisted largely of screening in the greenhouse the more promising varieties and selections for reaction to races 1 and 6. Later, many other breeding lines from Arkansas, Louisiana, and Texas rice experiment stations were screened. Material grown in the field and harvested in the late summer or early fall is available for greenhouse testing from November through March.

The method used for developing blast-resistant varieties in the United States (*13*) is as follows:

(1) Seeds from F_3 or F_4 progenies of crosses between varieties possessing the desired resistance genes are saved.

(2) Seedlings from these progenies are inoculated in the greenhouse to determine reaction to race 6. Susceptible selections are not tested further.

(3) Seedlings that are resistant to race 6 are then inoculated in the greenhouse with race 1.

(4) Selections that carry resistance to races 1 and 6 are sown in the field for further evaluation of field and grain characters. Many of the less desirable lines are eliminated at this stage.

(5) Seedlings of the selected lines are inoculated in the greenhouse with races 1 and 6 to confirm results of previous tests.

(6) Selections that are resistant to races 1 and 6 then are inoculated with races 2 or 4, 7, 8, 16, and 19, as time and facilities permit.

(7) Selections that are resistant to all races are then grown in the field in observation rows or in yield tests for further evaluation as potential new rice varieties.

Selections that are resistant to the desired races of blast but do not appear promising for developing an improved commercial variety are crossed with a suitable variety or strains. Testing for reaction to blast is then repeated. This operation may be repeated several times, or until suitable plant types occur.

Many breeding lines have been tested, and promising strains of all grain types have been developed to combine resistance to several of the more common races of blast found in the United States. In Arkansas, in greenhouse tests, Nova was resistant or moderately resistant to most of the races of blast. In field tests, it was considerably more resistant than was Nato. Nova was released in 1963 jointly by the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Arkansas Agricultural Experiment Station (*49*).

Brown Leaf Spot

Brown leaf spot, caused by the fungus *Helminthosporium oryzae* B. de Haan, is a common disease of rice in humid areas. In 1941 a report was published (*4*) concerning the mode of inheritance of resistance to *Helminthosporium* in a cross of a moderately resistant and a susceptible variety. Inoculation with conidia was used to induce infection. All gradation from moderately resistant to susceptible occurred in the segregating populations. This indicated that the reaction was controlled by several genes lacking dominance.

The reaction of seedlings grown in the greenhouse showed a fairly close relationship with that of mature plants grown in the field and suggested the possibility of early elimination of a large proportion of susceptible segregates in breeding for resistance (*4*).

According to Nagai (*66*), he and Hara studied an especially susceptible mutant, and susceptibility proved to be due to a single recessive gene in crosses of a very susceptible and a normal plant.

A breeding program to develop varieties resistant to brown leaf spot was begun at Beaumont, Tex., about 1938. C.I. 9515, a resistant but agronomically undesirable strain selected from a cross made at Beaumont in 1938, was crossed with popular long-grain commercial varieties in 1945. Resistant selections from the 1945 crosses were crossed to commercial long-grain varieties in 1959. Selecting for resistance was started in the F_3 population by saving the more resistant plants in rows showing the best resistance, along with other desirable quality. A highly susceptible spreader variety was sown adjacent to each selection. Differences in disease reaction were relative and were more apparent between panicle rows than among individual plants. Resistance was based on the number and size of spots. The studies indicated that inheritance is not simple

and probably involves several genes. Selecting for resistance was continued through several generations or until apparent true breeding lines were established. Resistant lines possessing good agronomic characters were selected from the 1959 crosses.

Narrow Brown Leaf Spot

Narrow brown leaf spot, caused by the fungus *Cercospora oryzae* I. Miyake, is a common disease of rice in the Southern States. There are physiological races of the causal fungus (*26, 73, 74, 75*), but genes for resistance for each race are available. The mode of inheritance of reaction to *C. oryzae* has been studied (*4, 45, 47*). No linkage between genes for reaction to *Cercospora* and those for expression of five qualitative characters was found (*45*). Most of the work on the development of *Cercospora*-resistant varieties has been done in the field under conditions of natural infection. Selection is based on type of lesion and relative severity of infection. In Louisiana, a number of resistant selections were obtained when Blue Rose was crossed or backcrossed to Rexoro, although both parental varieties were susceptible to one or more races.

Straighthead

Straighthead is a physiological disease that occurs under certain environmental conditions in the United States. A breeding program to develop straighthead-resistant varieties was begun in the United States in 1953, at Eagle Lake, Tex. The method of testing consists simply of drill seeding the test entries in an area with a soil type, such as Hockley fine sandy loam, conducive to straighthead development and keeping the nursery test area continuously submerged after the initial irrigation (*82*). The reactions of the American rice varieties (*11, 12*) served as a basis for selecting parental varieties for resistance in a breeding program. Straighthead resistance is relative, and none of the varieties tested are immune or highly resistant. The resistance of Bluebonnet, Bluebonnet 50, Lacrosse, Prelude, and Toro is derived directly or indirectly from Fortuna, selected from the Pa Chiam variety obtained from Taiwan. C.I. 5094, selected from the Sinanpagh variety from the Philippines, served as the source of resistance in Texas Patna and the original Century Patna.

Testing selections from several crosses was begun in 1954. For example, straighthead-resistant selections were recovered from a cross of Bluebonnet (resistant) × Century Patna 231 (susceptible) and from backcrosses to Century Patna 231. Although a number of the straighthead-resistant selections from the Century Patna 231 crosses were promising and were seriously considered as new varieties, none were released. Belle Patna, from a different cross, was released as a new variety in 1961 (*23*). This variety has Bluebonnet as its source of straighthead resistance.

In the breeding program, straighthead-resistant selections have been obtained readily by selecting panicles from resistant or segregating lines for retesting in panicle rows. The number of genes involved in straighthead reaction was not established, but inheritance appeared to be relatively simple in crosses within the long-grain groups of varieties. Resistance seems to be dominant (*12*).

White Tip

White tip, first observed in Louisiana before 1930, was considered to be a physiological disease until 1949, when it was found to be caused by a seedborne, foliar nematode, *Aphelenchoides besseyi* Christie (*27*). However, by that time considerable progress had been made in selecting for resistance in nurseries in which the disease occurred rather consistently each year.

After white tip was found to be caused by a seedborne nematode, various methods were used to insure infection in order to determine the reaction of varieties and selections to white tip. These methods consisted of including heavily infested seed of susceptible varieties as spreader rows, using rice hulls containing large numbers of nematodes, or introducing nematodes from laboratory cultures into the irrigation water. Atkins and Todd (*15*) determined reaction of many rice varieties in the United States to white tip. No studies have been made on the genetics of inheritance.

Hoja Blanca

Hoja blanca is a virus disease of rice that occurs in the Western Hemisphere. In 1957, a large number of United States varieties and selections, as well as introduced varieties, were tested for hoja blanca reaction under conditions of natural infection in Cuba and Venezuela (*10*). On the basis of marked differences in disease reaction in the nursery tests, Arkrose, Asahi, Colusa, Lacrosse, Mo. R–500, and several experimental varieties were designated as sources of hoja blanca resistance for use in breeding.

Since both resistant and susceptible entries were found among a number of advanced-generation selections from two crosses having Lacrosse as one parent, it was concluded that the genes for resistance could be readily transferred in crosses. Other studies showed that resistance was genetically controlled and could be transferred to varieties of all grain types (*22*) and that resistance was dominant (*21*). Since 1957, other lines resistant to hoja blanca have been recovered from

several crosses between susceptible and resistant parents. Thus far, none have been released as varieties.

Gulfrose, released in 1960 as a hoja blanca-resistant variety (*1*, *28*), was an increase of a selection rated as resistant in the 1957 and subsequent tests. Nova, released in 1963, also a hoja blanca-resistant variety (*49*), was an increase from a selection rated as resistant in early tests.

Testing and breeding for resistance to hoja blanca are being continued in cooperation with Government and private agencies in several Central and South American countries. Much of the testing of varieties and breeding lines for reaction to hoja blanca has been done under conditions of natural infection in the field. This work has been done in foreign countries where epiphytotics of the disease usually occur. Hybrid and backcross plants and progeny lines also are tested in the greenhouse where plants are inoculated with viruliferous vectors. Since resistance to hoja blanca is dominant, backcross plants that carry resistance can be identified in greenhouse tests. Backcross seeds are planted in the greenhouse or field. As soon as the plants tiller, they are divided and part of the plant is tested for reaction to hoja blanca. The reaction can be determined by the time the plant flowers, so that plants carrying resistance can be identified and used as parents in the backcross program.

The pedigree method, the backcross method, and a modification of these two methods were used in Texas to develop long-grain varieties resistant to hoja blanca. The material used in the pedigree method was obtained by crossing the long-grain variety Bluebonnet 50 and several promising long-grain hybrid selections with the hoja blanca-resistant varieties Gulfrose and Tainan-iku No. 487 (P.I. 215,936). The F_1 plants were grown in the greenhouse during the winter of 1957-58, and the F_2 populations were grown in the field during the summer of 1958. In the fall of 1958, the seeds from 353 carefully selected F_2 plants were saved. A few grams of grain from each selection were milled in a test-tube miller, and alkali digestion and iodine-blue tests were performed. In 1959, progenies from each F_2 plant were grown in Colombia, Cuba, and Venezuela to test their reaction to hoja blanca; at Eagle Lake, Tex., to test their reaction to straighthead; and in the nursery at Beaumont, Tex., to advance each selection on a pedigree basis and to select on the basis of plant type and vigor.

In 1960, scientists at Beaumont selected 507 panicles from the better F_3 lines grown in 1959. Seed from each of these selections was sent to Colombia for further hoja blanca testing and progeny of each was grown in the breeding nursery at Beaumont. About 20 panicles were harvested from each row, and this grain was used to determine the cooking and processing quality of the F_4 lines.

Excellent hoja blanca readings from Colombia were obtained on the F_4 lines tested in 1960, as well as the F_5 and F_6 lines tested in 1961 and 1962. Hoja blanca-resistant selections were tested further for reaction to straighthead at Eagle Lake, for reaction to blast of seedlings at Beaumont, and for quality behavior in the cooperative Rice Quality Laboratory at Beaumont.

In 1962, a number of the more promising strains carrying hoja blanca resistance were grown in advanced yield trials at Beaumont. From the crosses made in 1957, hybrid selections of early and midseason maturity and short-, medium-, and long-grain types that are promising for resistance to hoja blanca are now available for extensive testing.

In the modification of the backcross method used in the hoja blanca breeding program, the F_1 plant of the cross Bluebonnet 50 $\times$ Gulfrose was backcrossed to Bluebonnet 50 in 1958. A total of 31 backcrossed seeds produced plants. The seeds from each plant were sent to the hoja blanca testing laboratory, then located at Camaguey, Cuba, and backcross populations carrying hoja blanca resistance were identified. Space-planted populations of each backcross line also were grown in the breeding nursery at Beaumont in 1959, and plants were selected from the lines that were promising for hoja blanca resistance. In 1960, F_3 lines were tested for hoja blanca reaction in Colombia, and for straighthead reaction at Eagle Lake. F_2 lines were also sown at Campo Cotaxtla, near Veracruz, Mexico, in the fall of 1959; and two crops per year were obtained through 1961. Selections from the Mexico nursery were sent to Colombia for testing for hoja blanca reaction and to Beaumont for grain quality testing. By the end of 1961, many long-grain selections promising for hoja blanca resistance were available for extensive testing at Beaumont. Long-grain selections of early and midseason maturity that are resistant to hoja blanca and straighthead and that possess Bluebonnet milling, processing, and cooking qualities were tested for yield and other field characters at Beaumont in 1963.

Since hoja blanca resistance is dominant, Bluebonnet 50 was used as the recurrent parent in the modified backcross method. The hoja blanca reaction of F_1 backcross plants was obtained at the hoja blanca testing laboratory at Baton Rouge, La. In 1963, F_1 plants with four backcrosses to Bluebonnet 50 were tested for hoja blanca reaction. Some of these plants are similar to Bluebonnet 50 in plant and grain type and they are resistant to hoja blanca.

Description of Varieties

The names and accession numbers of the 18 varieties reported in this section of the handbook are listed in table 9. These include the principal commercial varieties in the United States.

Short-Grain Varieties

In 1963, about 12.3 percent of the total rice acreage in the United States was sown with short-grain (Pearl) varieties.[5] In Arkansas, Louisiana, Mississippi, and Texas only 0.08 percent of the crop produced was the short-grain type, whereas in California, 67.7 percent was this type.

The commercial short-grain varieties grown in yield tests were Caloro, Cody, and Colusa. Rough rice and milled kernels of each of these three varieties are shown in figure 21. These and other short-grain varieties have rather slender culms, narrow (about 3/8-inch) leaf blades, and yellow or straw-colored rough hulls enclosing the kernels. A plant of Caloro is shown in figure 22. When milled, short-grain varieties usually yield as high a percentage of head rice (whole grain milled) as do the medium-grain varieties and higher than do the long-grain varieties. Short-grain varieties are not grown in the Southern States because the varieties available are not well adapted for this area and there is little demand in this area for rice of this type.

Caloro.—Caloro was selected from Early Wataribune in 1913 at the Biggs Rice Field Station, Biggs, Calif., and was distributed in the spring of 1921. It is an early to midseason, partly awned variety that heads and matures uniformly in California and produces relatively high yields with reasonably good milling quality on either virgin soil or old ricelands. It is the leading variety grown in California, yields well in Arkansas (*50*, *51*, *67*) and Missouri (*63*), and yields reasonably well in Louisiana and Texas. Although it appears to be adapted for growing under a wide range of conditions, it is grown principally in California. Caloro is the most important short-grain variety grown in the United States,

Cody.—Cody (*57*) was selected from the cross Colusa × Lady Wright at the Biggs Rice Field Station, Biggs, Calif. Seed of Cody was tested in Missouri and then increased and distributed to growers in Arkansas in the spring of 1944. Cody is an early-maturing, awnless variety that can be grown in all rice-producing States. It yields and mills well in the absence of diseases. It has been grown on a small acreage in Arkansas but has not been grown in California.

Colusa.—Colusa (*25*) was selected in 1911 at the Rice Experiment Station, Crowley, La., from Chinese, a variety introduced from Italy in 1909 by Haven Metcalf. It was tested at the Biggs Rice Field Station, Biggs, Calif., and distributed in 1917 and 1918. Colusa is an early-maturing, awnless variety of reasonably good milling quality that heads and matures rather uniformly and that produces relatively high yields on fertile land. In California it is much less productive than Caloro on old riceland of average fertility. However, when nitrogen fertilizer is applied at

[5] See footnote 2, p. 19.

Figure 21.—Rough rice and milled kernels of (*A*) Caloro, (*B*) Cody, and (*C*) Colusa.

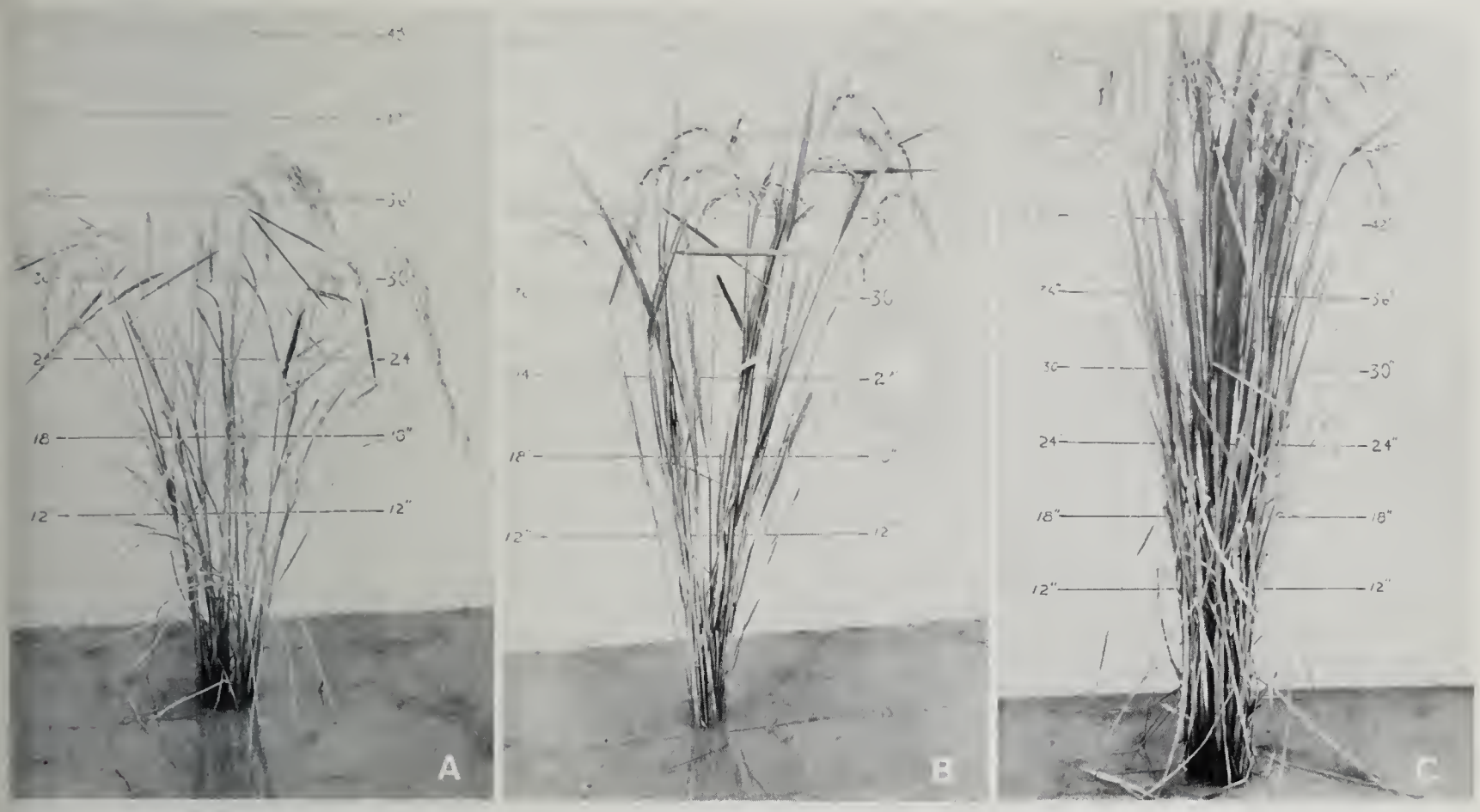

FIGURE 22.—Plants of (*A*) Caloro, (*B*) Nato, and (*C*) Rexoro.

TABLE 9.—*Name, C.I. number, FAO number, and registration number for reported rice varieties*

Grain type and variety	C.I. number [1]	FAO number [2]	Registration number [3]	Uniform group [4]
Short-grain:				
Caloro	1561–1	211	5	IV
Cody	8642	212	20	I
Colusa	1600	213	8	I
Medium-grain:				
Arkrose	8310	207	1	IV
Calrose	8988	1013	6	IV
Gulfrose	9416	1339		I
Magnolia	8318	216	12	I
Nato	8998	1133	13	I
Northrose	9407	1364		I
Zenith	7787	206	19	I
Long-grain:				
Belle Patna	9433	1334		VI
Bluebonnet 50	8990	1012	3	III
Century Patna 231	8993	1014	7	II
Rexoro	1779	214	14	V
Sunbonnet	8989	1019	15	III
Texas Patna	8321	221	16	V
Toro	9013	1134	18	III
TP 49	8991	1020	17	V

[1] Accession number, Cereal Crops Research Branch, Crops Research Division, Agricultural Research Service.
[2] Accession number, World Catalogue of Genetic Stocks—Rice. Food and Agriculture Organization of the United Nations.
[3] Registration number, American Society of Agronomy—U.S. Department of Agriculture (*48*).
[4] Uniform Yield Nursery Group number.

fairly high rates, it produces as much as Caloro. Colusa yields well in Missouri and fairly well on fertile land in Arkansas, but it frequently lodges when the crop is heavy. Colusa has been for many years, and still is the most popular early-maturing variety grown in California.

Medium-Grain Varieties

In 1963, 47.5 percent of the rice acreage in the United States was sown to medium-grain varieties.[6] In California, 32.3 percent of the rice acreage was sown to this type. Of the total rice production in the United States, Nato made up 38.6 percent, Zenith 0.1 percent, and the Roses (principally Arkrose, Calrose, Gulfrose, and Northrose) 8.7 percent.

The principal medium-grain varieties grown in the yield tests were Arkrose, Calrose, Gulfrose, Magnolia, Nato, Northrose, and Zenith. Rough rice and milled kernels of each of these seven varieties are shown in figure 23. These varieties, with the exception of Calrose, have rather stout culms and relatively wide (about 5/8-inch) leaf blades. A plant of Nato is shown in figure 22. When milled, medium-grain varieties usually yield more head rice (whole kernels) than the long-grain varieties yield.

ARKROSE.—Arkrose (*57*) was selected at the Rice Branch Experiment Station, Stuttgart, Ark., from the cross Caloro × Blue Rose. Arkrose was distributed in 1942. Arkrose matures about a week earlier than Supreme Blue Rose, and in some sections of Arkansas it is meeting the demand for a Blue Rose type. Arkrose yields well and is relatively easy to thresh. It is similar to Blue Rose in milling and table quality. It is more difficult to dry artificially than are most long-grain varieties. Arkrose has been grown in Arkansas and, rarely, in Texas.

CALROSE.—Calrose (*57*) was selected at the Biggs Rice Field Station, Biggs, Calif., from the cross Caloro × Calady backcrossed to Caloro. It is a partly awned variety very similar in growth habit and maturity to Caloro. In California, Calrose appears to be equal to Caloro in yielding capacity and in milling quality. It stands up well, matures evenly, and is as easy to combine as Caloro. Calrose was grown on a small acreage for the first time in 1948, and in 1963 it was grown on 32.3 percent of the California rice acreage.

GULFROSE.—Gulfrose was selected from the cross Bruinmissie selection × Zenith at the Rice-

[6] See footnote 2, p. 19.

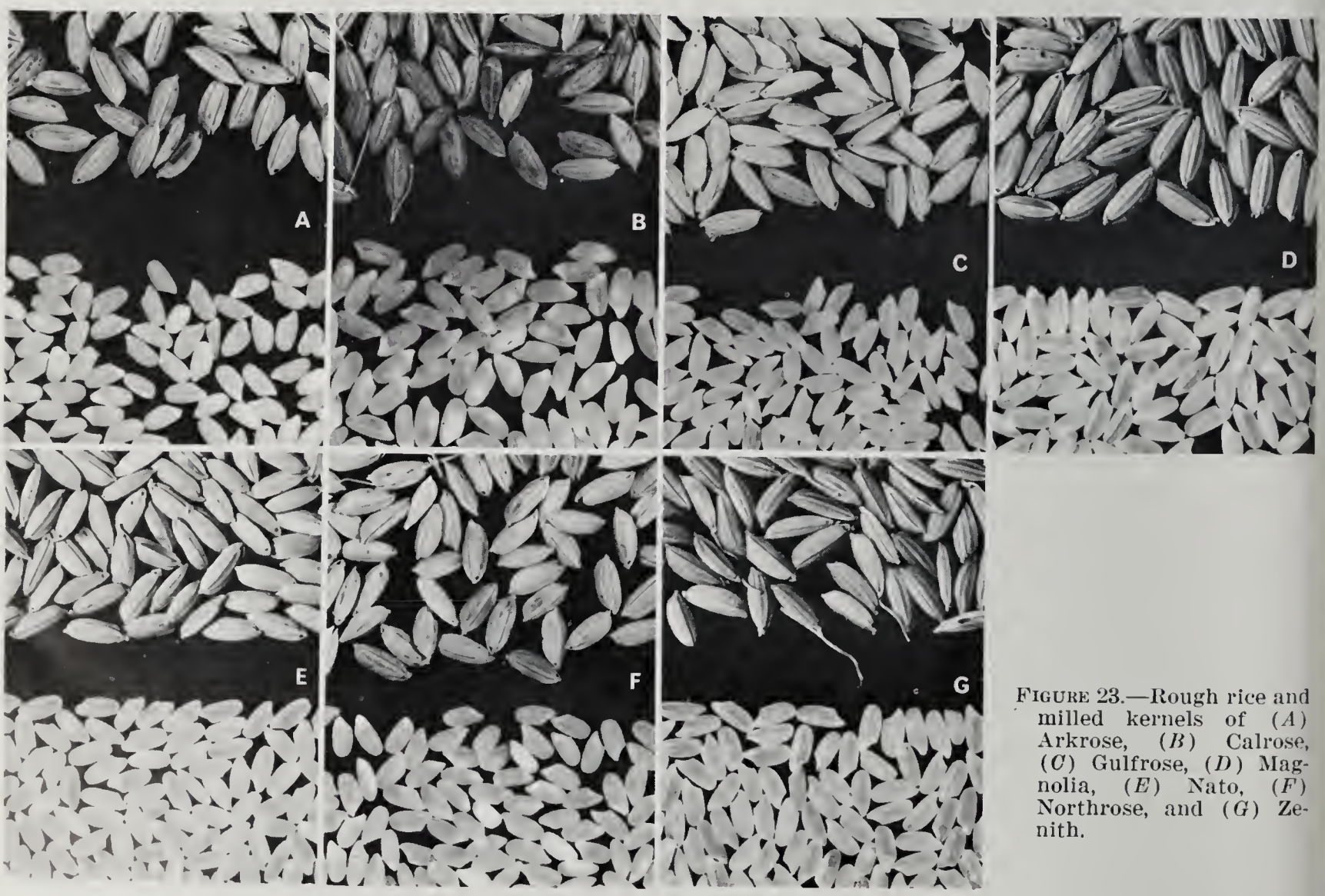

FIGURE 23.—Rough rice and milled kernels of (*A*) Arkrose, (*B*) Calrose, (*C*) Gulfrose, (*D*) Magnolia, (*E*) Nato, (*F*) Northrose, and (*G*) Zenith.

Pasture Research and Extension Center, Beaumont, Tex., in 1953, and released in 1960 (*1*). It is similar to Zenith in plant and grain type but matures a few days earlier. Gulfrose is resistant to hoja blanca. This was the principal reason for releasing it since none of the leading United States varieties grown at that time were resistant. Gulfrose was grown on a limited acreage in the southern rice area in 1963.

Magnolia.—Magnolia (*57*) was selected at the Rice Experiment Station, Crowley, La., from the cross Improved Blue Rose × Fortuna. It was released in 1945. It is an early-maturing variety that matures about the same time as Zenith. Magnolia usually heads and matures evenly and it combines more readily than Zenith. Under favorable conditions it produces relatively high yields, with good milling quality. The grain can be dried satisfactorily. Magnolia appears to be adapted for growing throughout the southern rice area.

Nato.—Nato was selected from the cross (Rexoro × Purple-leaf) × Magnolia at the Rice Experiment Station, Crowley, La. It was released in 1956. It is an early-maturing variety with comparatively short, strong straw; it produces good field and mill yields; and it is suitable for making dry cereals and for other uses for which varieties of similar type are adapted (*43*). Nato was the leading rice variety in the United States in 1963.

Northrose.—Northrose was selected in 1955 from the cross Lacrosse × Arkrose and released from the Rice Branch Experiment Station, Stuttgart, Ark., in 1962. It is an early-maturing variety, and its outstanding characters are its short, stiff straw and high grain yields. Because of its tendency to be slightly chalkier than Nato and because of its occasional low yields of head rice, Northrose was not designated for general production. Instead it was designated a special-purpose variety for relatively late seeding in northeast Arkansas where its earliness and high degree of lodging resistance are urgently needed (*52*, *53*).

Zenith.—Zenith (*57*) was selected from Blue Rose in 1930 by Glen K. Alter, near DeWitt, Ark. In 1931, several selections were tested in the cooperative breeding program at the Rice Branch Experiment Station, Stuttgart, Ark. Of these selections, Arkansas 141–8 proved to be the best; it was named Zenith and distributed in 1936. Zenith is an early-maturing, awnless variety, and it is uniform in heading and in maturing. In 1954, Zenith was grown on over 50 percent of the rice acreage in the Southern States. It has since been replaced by the shorter strawed, smooth-hulled Nato variety. Strains similar to Zenith have been isolated from Early Prolific.

Long-Grain Varieties

In 1963, 49.1 percent of the rice produced in Arkansas, Louisiana, Mississippi, and Texas was the long-grain type.[7] The leading long-grain varieties were Bluebonnet 50 and Sunbonnet, comprising 33.5 percent of the southern acreage; Belle Patna, 10.6 percent; Rexoro, 2.9 percent; and Century Patna 231 and Toro, each 1.1 percent.

The principal long-grain varieties grown in the field tests were Belle Patna, Bluebonnet 50, Century Patna 231, Rexoro, Sunbonnet, Texas Patna, Toro, and TP 49. Rough rice and milled kernels of each of these eight varieties are shown in figure 24. Most of these varieties have rather large culms and relatively wide (about 5/8-inch) leaf blades. A Rexoro plant is shown in figure 22. Because of the long growing season required, Rexoro, Texas Patna, and TP 49 are grown only in Louisiana and Texas.

Belle Patna.—Belle Patna was selected from the cross Rexoro × (Hill selection × Bluebonnet) at the Rice-Pasture Research and Extension Center and was released in 1961 (*2*). It is a very early-maturing, slender-grain variety with cooking quality similar to Rexoro.

Bluebonnet 50.—Bluebonnet 50 was selected from Bluebonnet in 1950 at the Rice-Pasture Research and Extension Center. Bluebonnet was a progeny of the cross Rexoro × Fortuna Seed of Bluebonnet 50 was distributed in 1951. Bluebonnet 50 is a midseason variety. It has relatively short, stiff straw, and the grains are partly awned. It yields and mills well and has good cooking quality, being comparable to Rexoro and Texas Patna in those characters. The grain of Bluebonnet 50 is thicker than that of Rexoro but is more slender than that of Nira. Bluebonnet 50 is well suited for harvesting by the combine-drier method.

Century Patna 231.—Century Patna 231 (*57*) was selected in 1946 from a cross between Texas Patna and a selection from the cross Rexoro × Supreme Blue Rose at the Rice-Pasture Research and Extension Center. It was released to farmers in the spring of 1951. It is an early-maturing, slender-grain variety. Century Patna 231 usually matures about 3 days later than Zenith. It has rather short straw and narrow, semidrooping leaves, and tillers exceptionally well. Century Patna 231 is moderately resistant to the common races of the fungus causing the narrow brown leaf spot disease, so the leaves and stems remain alive for some time foliowing maturity. In cooking quality, Century Patna 231 is inferior to Bluebonnet 50, Rexoro, and Texas Patna.

[7] See footnote 2, p. 19.

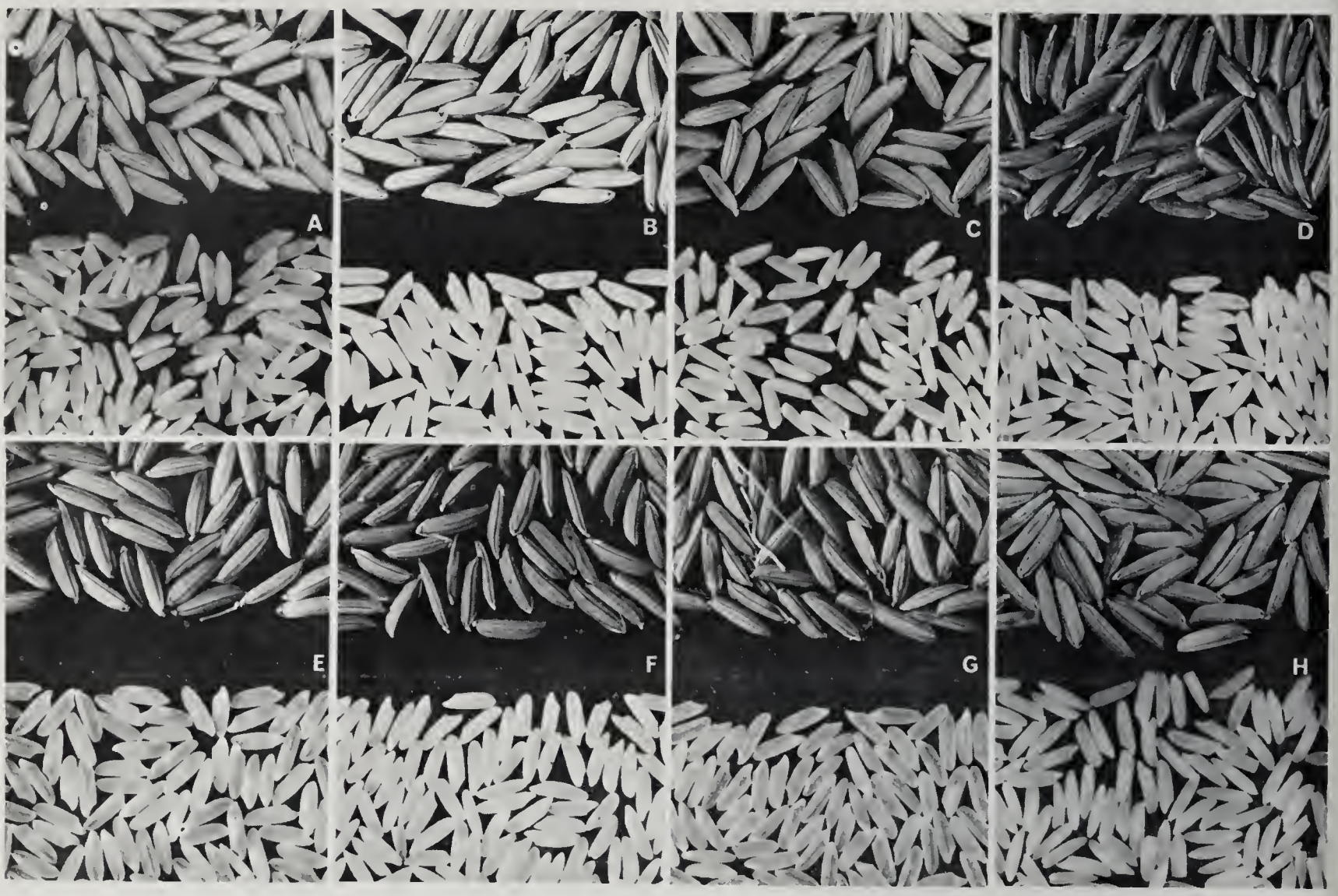

FIGURE 24.—rough rice and milled kernels of (*A*) Belle Patna, (*B*) Bluebonnet 50, (*C*) Century Patna 231, (*D*) Rexoro, (*E*) Sunbonnet, (*F*) Texas Patna, (*G*) Toro, and (*H*) TP 49.

REXORO.—Rexoro (*25*) was selected in 1926 at the Rice Experiment Station, Crowley, La., from the Marong-Paroc variety introduced from the Philippine Islands in 1911 by the U.S. Department of Agriculture. Rexoro was distributed by the Department in cooperation with the Louisiana Agricultural Experiment Station in 1928. Rexoro is a stiff-strawed, late-maturing, slender-grain rice that yields and mills well for a variety of this type. The cooking quality is very good.

SUNBONNET.—Sunbonnet was selected from Bluebonnet at the Rice Experiment Station, Crowley, La., and released in 1953 (*42*). Sunbonnet is similar to Bluebonnet in plant characters, although somewhat taller than Bluebonnet 50. Sunbonnet is similar to Bluebonnet in cooking quality but is usually slightly superior in milling quality.

TEXAS PATNA.—Texas Patna (*57*) was selected in 1935 at the Rice-Pasture Research and Extension Center from the cross Rexoro × C.I. 5094. Seed of Texas Patna was distributed to growers in 1942. Texas Patna is similar to Rexoro but grows slightly taller, matures about 10 days earlier, and has a more translucent grain. It yields and mills well. Because Texas Patna is slightly taller than Rexoro, it is more inclined to lodge when grown on rich land. It is well suited for combining and the grain is easy to dry. Texas Patna is grown principally in the Eagle Lake section of Texas and to a limited extent in Louisiana.

TORO.—Toro was selected from a cross in which the varieties Bluebonnet, Blue Rose, and Rexoro were the parents. It was developed at the Rice Experiment Station, Crowley, La., and released in 1955 (*42*). It is similar to Bluebonnet 50 in plant height and straw strength. It yields and mills well, but it is about as hard to thresh as Zenith. The grain type is similar to that of Bluebonnet, but the cooking quality of these two varieties is different. Toro, when cooked, is firmer than Bluebonnet but not as dry and flaky.

TP 49.—TP 49 (*48*) was selected from the cross Texas Patna × (Rexoro × C.I. 7689) at the Rice-Pasture Research and Extension Center

and released in 1951. It is a late-maturing, slender-grain variety, similar to Texas Patna except that it has shorter and stronger straw and somewhat thicker grain.

Other Kinds of Rice

Most of the rice varieties grown in the United States are generally called common varieties; that is, they have no distinctive flavor or odor when cooked, and the starch in the endosperm contains both amylose and amylopectin. There are, however, minor acreages of two other kinds of rice—aromatic or scented, and glutinous or waxy.

Aromatic or Scented.—Varieties having a distinctive odor and flavor somewhat like popcorn when cooked are known as aromatic or scented varieties; they are cultivated widely in India and other southeast Asian countries. Scented rices are said to be low yielding; but because they are greatly esteemed, they may sell at twice the price of other rices of fine quality. The odor and flavor are assumed to be due to an aromatic substance. Since aroma is sometimes noted in the growing crop, it is not limited to the endosperm. The aroma occurs in waxy as well as in ordinary types of rice.

Two varieties, Delitus and Salvo, were selected from introductions released in the United States. Delitus has been grown commercially, and attempts have been made to place it on the market. A cross between Rexoro and Delitus produced Delrex and R–D, which fully retain the flavor. R–D is a productive, medium-late variety that should make possible profitable marketing of scented rice as a food specialty. C.I. 9483, an early-maturing selection from R–D × Rexoro-Zenith, has improved milling quality and a more translucent endosperm.

Glutinous or Waxy.—Waxy varieties, commonly called glutinous, differ from common varieties in that they contain only amylopectin starch in the endosperm. Glutinous rice is grown on about 1,000 acres in California each year. It is grown as a specialty crop, and the acreage needed to meet market demands has been small. Historically, the principal use of glutinous rice has been for preparing oriental ceremonial foods and confections. In some countries, glutinous rice is harvested slightly green, is lightly parched before milling, and is used as a breakfast food. Recent research has shown that glutinous rice flour may find a special use in the frozen food industry. The flour, when made into foods for freezing, such as white sauce and desserts, resists syneresis (separation or weeping) when thawed after freezing.

Mochi Gomi is the variety of this type grown in California. It is a short-grain, midseason variety. Compared to Caloro, it has about the same straw strength and is about 6 inches shorter. The glumes are less pubescent, and the grain matures 5 to 10 days later. The waxy-white kernels are opaque.

Performance of Varieties

The performance of rice varieties is studied at several rice experiment stations in the southern rice area and in California. The grain yields and milling quality data reported for the southern rice area in this bulletin were obtained from the Uniform Yield Nurseries from 1951 through 1961. In these nurseries, varieties are grown in 3- or 4-row, randomized, quadruplicated, drill-seeded plots. These nurseries were grown each year in Arkansas, Louisiana, and Texas, and in some years in Florida and Mississippi. Yields reported for California were obtained from drill-seeded, quadruplicated nursery plots except in 1960 and 1961, when the rice was seeded in the water.

Entries in the Uniform Yield Nurseries grown in the southern rice area are grouped according to grain type and length of growing season. The six groups are: I, short- and medium-grain early varieties; II, long-grain early varieties; III, long-grain midseason varieties; IV, short- and medium-grain midseason varieties; V, long-grain late varieties; and VI, medium- and long-grain very early varieties. There usually were 14 entries in each group, many of them experimental varieties. Group numbers of the 18 varieties reported in this section of the handbook are in table 9, p. 43.

The varietal experiments at each location were on soil that was typical of large areas in the respective States. In Florida the tests were made on Everglades peaty muck soil. Crop rotation, seedbed preparation, time and rate of seeding, fertilization, and weed control used for these experiments were practices that were thought to be optimum for each area.

Average grain yields in table 10 were obtained from 1951 through 1961 at the following locations: Rice Branch Experiment Station, Stuttgart, Ark.; Everglades Experiment Station, Belle Glade, Fla.; Rice Experiment Station, Crowley, La.; Delta Branch Experiment Station, Stoneville, Miss.; Rice-Pasture Research and Extension Center, Beaumont, Tex.; and Rice Experiment Station, Biggs, Calif. The actual number of years each variety was tested is shown. The yield of each variety is compared with the yield of one or two standard varieties that were grown throughout the entire period.

In Arkansas, the short-grain varieties all produced the highest average yields except those of the medium-grain varieties Arkrose and Northrose. All medium-grain varieties except Magnolia produced higher average yields than did

TABLE 10.—*Grain yield for 18 rice varieties grown at 6 locations during the 11-year period, 1951–61*

Grain type and variety	Arkansas			Florida			Louisiana			Mississippi			Texas			California		
	Years grown	Yield [1]		Years grown	Yield [1]		Years grown	Yield [1]		Years grown	Yield [1]		Years grown	Yield [1]		Years grown	Yield [2]	
	Number	*Pounds*	*Percent*	*Number*	*Pounds*	*Percent*	*Number*	*Pounds*	*Percent*	*Number*	*Pounds*	*Percent*	*Number*	*Pounds*	*Percent*	*Number*	*Pounds*	*Percent*
Short-grain:																		
Caloro	11	4201	109	5	2023	61	10	2852	91	6	5836	129	9	3314	94	11	3375	100
Cody	10	4149	111	5	2559	78	10	3423	113	5	4034	89	10	3642	100			
Colusa	11	4242	110	5	2862	87	11	2743	88	6	4036	90	11	3754	103	11	3555	105
Medium-grain:																		
Arkrose	11	4338	112	5	3344	101	10	3080	98	6	6064	134	9	3575	101			
Calrose	11	4174	108	5	2073	63	10	2721	87	6	5514	122	9	3134	89	11	3544	105
Gulfrose	4	4715	107				4	2804	80	3	4715	103	4	3559	90			
Magnolia	11	4008	104	5	2806	85	11	3114	100	6	4273	95	11	3454	95			
Nato	10	4510	109	5	3640	110	10	3250	107	6	4477	99	10	3786	103			
Northrose	4	4933	112				4	3802	109	3	5337	117	4	4158	105			
Zenith	11	4156	108	5	3232	98	11	3231	104	6	4227	94	11	3593	98			
Long-grain:																		
Belle Patna	4	3834	87				4	3245	93	3	4543	99	4	3476	87			
Bluebonnet 50	11	3556	92	5	3365	102	11	3012	96	6	4791	106	11	3703	102			
Century Patna 231	11	4128	107	5	3350	102	11	3674	118	6	5083	113	11	3540	97			
Rexoro							11	2128	68				11	2676	73			
Sunbonnet	11	3592	93	5	3758	114	11	2922	94	6	4863	108	11	3827	105			
Texas Patna							11	2404	77				11	3009	82			
Toro	10	4113	100	5	3594	109	10	3237	106	6	4869	108	10	3738	102			
TP 49							11	2417	77				11	3269	90			

[1] Percent of the yield is based on the mean of Zenith and Bluebonnet 50 for the years grown; quantity is given in pounds per acre.
[2] Percent of yield is based on the yield of Caloro.

most of the long-grain varieties. Century Patna 231 produced nearly the same average yield as the medium-grain varieties, but the other long-grain varieties produced lower average yields.

In Florida, none of the short-grain varieties produced an average yield that was as high as that of the higher yielding medium- or long-grain varieties. Of the medium-grain varieties, Nato produced the highest average yield. The long-grain variety Sunbonnet produced the highest average yield of any variety.

In Louisiana, Cody was the only short-grain variety that produced an average grain yield comparable to the yields of the higher yielding medium- and long-grain varieties. The highest yielding medium-grain varieties were Nato and Zenith, except for Northrose, which was grown only 4 years. Of the long-grain varieties, Century Patna 231 and Toro produced high average yields. The late-maturing, long-grain varieties Rexoro, Texas Patna, and TP 49 produced quite low yields.

In Mississippi, Caloro produced the highest average yield of the short-grain varieties tested, but the other two short-grain varieties produced quite low yields. Arkrose, Calrose, and Northrose produced highest average yields of the medium-grain varieties tested. The average yield of these three varieties was somewhat higher than that of the long-grain varieties. Of the long-grain varieties, Century Patna 231 produced the highest yield. All long-grain varieties except Belle Patna produced higher average yields than did many of the commonly grown medium-grain varieties.

In Texas, the short-grain varieties Cody and Colusa produced average yields comparable to the higher yielding medium- and long-grain varieties. Of the medium-grain varieties, Nato and Arkrose produced highest average yields except for Northrose, which was grown only 4 years. Sunbonnet, Bluebonnet 50, and Toro produced highest average yields of the long-grain varieties.

In California, Colusa and Calrose produced slightly higher average yields than did Caloro.

The average number of days from seeding to maturity, average plant height, estimated straw strength, and pubescence and color of hull for the 18 varieties included in this handbook are given in table 11.

Milling quality was determined each year for the varieties grown in the Uniform Yield Nurseries. Included in table 7, p. 36, are the average milling yields of hulls, bran, total, and head rice for each of 18 varieties grown in the Uniform Yield Nurseries in Arkansas, Louisiana, and Texas for the years 1958–61. Milling yields were determined according to the modified procedure of Beachell and Halick (*19*). Treatment and preparation of Uniform Yield Nursery samples before milling was described in the section "Testing for Milling, Cooking, and Processing Qualities," p. 33. The average milling yields of hulls ranged from 18 percent for the short-grain varieties Caloro and Colusa to 21 percent for the long-grain variety Century Patna 231. Average bran yields ranged from 9 percent to 13 percent. In general, bran yields were lower for short- and medium-grain varieties than for long-grain varieties. Northrose, a newly released, special-purpose, medium-grain variety yielding an average of 12 percent bran, was an exception. The late-maturing, long-grain varieties Rexoro and Texas Patna grown only in Louisiana and Texas produced the highest bran yields (13 percent) of any of the varieties tested.

The average yield of total milled rice varied from 67 percent for Century Patna 231 to 73 percent for Caloro and Colusa. Short-grain varieties, as a group, produced slightly higher yields of total milled rice than did medium- and long-grain varieties. The medium-grain variety Northrose and the long-grain varieties Century Patna 231, Rexoro, and Texas Patna gave the lowest total milled rice yields.

Head rice yields for the varieties listed in table 7 are reported as average values and as individual minimum and maximum (range) values. Average yields of head rice varied widely among the varieties, from 52 percent for Rexoro to 69 percent for Calrose. In general, the average yield of head rice was highest for the short- and medium-grain varieties and lowest for the long-grain varieties. Toro, a long-grain variety yielding 67 percent of head rice, was an exception. The milling quality of this variety has been noted in earlier publications (*19*, *41*). Individual minimum and maximum values of head rice yields also varied widely. This variability was evident, not only among varieties but also within the varieties. Individual minimum head rice yields ranged from 33 percent for Arkrose to 63 percent for Calrose, Magnolia, and Nato; whereas individual maximum values ranged from 61 percent for Rexoro to 75 percent for Colusa.

Choosing the Variety

Several factors affect the choice of a variety. These are listed by Johnston, Cralley, and Henry (*51*) as market demand, satisfactory yielding ability, location, proposed seeding date, soil fertility or anticipated fertilizer practices, relative maturity, susceptibility to diseases that may occur, and seed supply. Growers of large acreages may wish to sow two or three varieties that differ in date of maturity and grain type in order to extend the harvesting period and to provide rice of different types for the market.

A grower should carefully consider market re-

TABLE 11.—*Plant characters for 18 rice varieties grown at 6 locations during the 11-year period, 1951–61* [1]

Grain type and variety	Average time from seeding to maturity [2]						Average plant height						Estimated straw strength [3]	Hull pubescence [4]	Hull color
	Arkansas	Florida	Louisiana	Mississippi	Texas	California	Arkansas	Florida	Louisiana	Mississippi	Texas	California			
	Days	*Days*	*Days*	*Days*	*Days*	*Days*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*			
Short-grain:															
Caloro	141	149	145	133	138	153	46	31	44	39	46	35	Weak	R	Straw.
Cody	129	127	122	[5] 124	119	-------	44	36	42	39	46	-------	Midstrong	R	Straw.
Colusa	130	128	123	124	118	134	46	37	43	36	47	34	Very weak	R	Straw.
Medium-grain:															
Arkrose	150	153	150	144	142	-------	52	44	50	47	52	-------	Very weak	R	Straw.
Calrose	141	148	143	129	137	153	46	32	43	37	46	33	Weak	R	Straw.
Gulfrose	126	-------	121	123	116	-------	48	-------	43	37	47	-------	Weak	S	Straw.
Magnolia	134	127	127	131	121	-------	51	45	46	42	50	-------	Weak	R	Straw.
Nato	132	127	126	130	122	-------	47	41	42	41	47	-------	Midstrong	S	Straw.
Northrose	134	-------	130	128	123	-------	46	-------	42	37	43	-------	Strong	S	Straw.
Zenith	133	129	126	134	122	-------	50	44	46	44	50	-------	Midstrong	R	Straw.
Long-grain:															
Belle Patna	115	-------	108	118	109	-------	43	-------	42	36	45	-------	Weak	S	Straw.
Bluebonnet 50	149	145	140	147	137	-------	47	44	45	49	50	-------	Strong	S	Straw.
Century Patna 231	136	133	131	137	126	-------	47	37	43	44	48	-------	Strong	S	Gold.
Rexoro	-------	-------	174	-------	172	-------	-------	-------	50	-------	52	-------	Strong	S	Gold.
Sunbonnet	148	143	140	147	137	-------	52	47	48	51	54	-------	Strong	S	Straw.
Texas Patna	-------	-------	166	-------	149	-------	-------	-------	50	-------	55	-------	Very weak	S	Gold.
Toro	148	144	140	148	137	-------	49	44	45	48	49	-------	Strong	S	Straw.
TP 49	-------	-------	172	-------	165	-------	-------	-------	48	-------	52	-------	Weak	S	Gold.

[1] Years of test: Arkansas, 1951–61; Florida, 1953–56; Louisiana, 1951–61; Mississippi, 1959–61; Texas, 1951–61; and California, 1951–61.
[2] Average seeding date: Arkansas, May 7; Florida, March 31; Louisiana, April 17; Mississippi, May 18; Texas, April 24; and California, May 6.
[3] Based on results for Arkansas and Texas.
[4] R = pubescent; S = glabrous.
[5] 2-year average.

quirements in selecting varieties to grow. He or his marketing agent may have difficulty in selling his rice if it is of poor quality, even though locally the variety may produce high yields. Also, growing a short- or medium-grain variety on a limited basis in an established long-grain district, for example, can pose real problems to the grower, driers, warehousemen, and millers to prevent mixtures of the different types.

Seeding rice on highly fertile soil, such as newly cleared woodland, "new ground," or a field used as a reservoir just before being seeded to rice, would necessitate the choice of a stiff-strawed variety that would be less likely to lodge. Even on old riceland low in natural fertility, if a grower anticipates using heavy rates of nitrogen fertilization, with part of it applied relatively late, such a practice may make it desirable to choose a relatively early-maturing variety. Growers in the northern part of ricegrowing areas in the United States are limited to early-maturing varieties because of the somewhat shorter growing season and cooler night temperatures than those prevailing farther south. It may be desirable to avoid a given variety because of its susceptibility to a certain disease when rice is to be grown under conditions known to be favorable for development of that disease.

Varietal Response to Seeding Date

By Nelson E. Jodon

Results of Tests With Older Varieties

Growers need to know how rice varieties will respond when sown at various dates. They should be able to tell the probable effect on yield, days to full maturity, plant height, milling quality, and other characters. Date-of-seeding tests have been conducted at Arkansas, Louisiana, Texas, and California rice experiment stations.

At Stuttgart, Ark., an experiment was carried on for 5 years with 10 varieties seeded at three dates (*5*). The average seeding dates were April 20, May 11, and June 5. Bluebonnet and Blue Rose yielded well from the first two seedings but usually matured too late when seeded in June. Arkrose yielded about the same from each of the seeding dates. The highest average yields from the latest seeding were made by Cody and Zenith, which have shorter growing seasons.

Most varieties sown in June in Arkansas risk injury by possible October frosts, although Arkrose and Zenith seeded in mid-June and Caloro and Cody seeded late in June have produced satisfactory yields (*51*). Nato should be seeded before the first of June and Bluebonnet by May 25. In the northern part of the State, seeding should be 7 to 10 days earlier.

In an Arkansas experiment, Arkrose and Blue Rose matured in shorter periods of time when sown late than did Bluebonnet (*3*). Varieties that responded to the shortened days of late summer by heading at nearly the same date whether seeded early or late were termed photosensitive. They also headed out quickly and uniformly. Length of time required for the photosensitive varieties to reach the heading stage decreased with each delay in the seeding date; plant height also decreased. Varieties that did not continue to shorten their growing period in response to late seeding were termed indifferent.

In Louisiana, the maximum number of days to flowering resulted from seedings on March 1 or March 15, except for the variety Caloro (*37*), in an experiment reported in 1936. The minimum for all varieties was from June 15 seedings. The difference between maximum and minimum days to flowering was a varietal characteristic. Some varieties tended to have a comparatively fixed growing period; others tended to head at a certain date late in the season, and if sown late, their growing periods were shortened materially. The maximum number of days from first heading to full maturity was 45; this number added to the number of days to flowering for each variety gave the total length of the growing period.

Another field plot experiment with six varieties was conducted over a 5-year period in Louisiana and reported in 1944 (*38*). The seeding dates were approximately the 15th and the 1st of each month from March 15 to June 15. Best yields were obtained from April 1 and May 1 seedings. Lower yields were obtained from June seedings than from April and May seedings.

The rice varieties Bluebonnet, Magnolia, Rexoro, and Zenith were grown in a date-of-seeding test in Louisiana and reported in 1953. In all, 27 seedings were made on dates as early as February 20 and as late as June 20 in the years 1941 to 1952 (*40*). Usually, four seedings were made each season. A tabular guide (*40*) for use in planning seeding schedules gave, for alternate days during the planting period, the growing season midpoint date (latest date to topdress), date of first heading, date when mature for combining, and total length of the growing period.

Nine varieties were seeded monthly from mid-March to mid-July in a 3-year experiment conducted at Beaumont, Tex., (*72*) and reported in 1954. Yields of early varieties showed no definite relation to seeding date, but midseason varieties gave markedly lower yields from May and later seedings. Late varieties gave the best yields from the earliest seedings and failed to mature from June and July seedings.

Effects of 10-hour daylight periods on length of growing period were studied in Texas (*17*). The day length was reduced by covering the

plants part of each day. Similar results were obtained from the 10-, 20-, and 30-day periods of short-day treatment. Two groups of varieties, termed sensitive and less sensitive, were compared. Varieties in the sensitive group showed a marked reduction in the number of days from seeding to heading when the treatments began about 50 days after seeding. The less sensitive varieties in general responded only slightly from the 50-day treatment but responded more when the treatments were started 60 to 80 days after seeding. The response depended on the variety. Reduction in length of growing period was accompanied by reduction in number of tillers and panicles, plant height, and straw and grain weight.

At Biggs, Calif., a date-of-seeding test was conducted for 9 years (*54*). Three seedings of the Wataribune variety were made each year, beginning as early as possible in the spring. The seedings were made at 2-week intervals. In all but 1 year's test, the highest yields were obtained from the earliest seeding.

Results of Tests With Newer Varieties and Selections

Tests similar to those reported in 1953 (*40*) were continued in Louisiana in the 9 years from 1953 through 1961 (*44, pp. 8–25*). In these experiments, seedings were made each year in March, April, May, and June. Each year the seedings were made to coincide with peaks of planting operations on farms in the area. Entries included varieties from four maturity groups. These included Nato (early), Sunbonnet and Toro (midseason), Blue Rose and R–D (medium late), and Rexoro (late). They mature in about 120, 135, 150, and 165 days, respectively. Extra early types (100-day group) were first included in 1957. One or two standard varieties representative of each maturity group were tested throughout the 9-year period. Each year additional entries of current interest were included.

Data for individual varieties are used in the following discussion of length of life cycle. Data for yield, height, and milling quality were averages of a standard variety and two other varieties or selections belonging to each of the four maturity groups, except in the late group. In the late group, data for only Rexoro and one selection were used for 2 of the years. The early group included Nato and two other varieties; the midseason group, Sunbonnet, Toro, and one other variety; the medium-late group, Blue Rose, R–D, and one other variety; and the late group, Rexoro and one other variety. Thus, the three varieties included in maturity-group averages for each month of the seeding period were the same in any 1 year; but, aside from the standard variety, they were not necessarily the same from year to year.

Length of Life Cycle in Relation to Seeding Date.—Average number of days from seeding to first heading by monthly seeding date for six varieties representing four maturity groups are summarized in table 12. Date of first heading was used as the criterion of the length of growing season of varieties, since it can be determined more precisely than date of maturity. The length of the period from first heading to maturity ranged from 35 to 40 days for the varieties listed. During warm weather, however, varieties that head very evenly may ripen in 30 days after the tips of panicles first emerge from the boot; whereas late in the growing season, the period from panicle emergence to full maturity may be 45 to 50 days.

Relative heading dates of five of the six varieties were fairly constant when sown at successively later dates, although the number of days from seeding to heading was progressively fewer. Nato headed 14 to 18 days earlier than Sunbonnet or Toro. Sunbonnet and Toro headed 12 to 19 days earlier than R–D. Rexoro was 9 to 17 days later than R–D. The number of days from seeding to heading for Blue Rose decreased more than some varieties as seeding was delayed. Blue Rose headed 1 day later than R–D when sown in March; but when sown in June, it headed 19 days earlier than R–D and 7 days earlier than Sunbonnet.

The reduction of length of life cycle of Blue Rose from successive seedings is an example of photoperiodic response. This response is governed by the length of the dark period during the 24-hour day. Blue Rose may be termed photosensitive and the other varieties may be said to have relatively inflexible growing seasons because their life cycles tend to remain constant in length once a certain minimum has been reached. For example, Nato seeded in June reached maturity in only 4 days less time than when it was seeded in May.

Low temperatures in the early spring retard germination and seedling development, thus extending the length of the life cycle. Average lengths of life cycles from April seedings were 17 days less than from March seedings. Those from May seedings were only 8 days less than from April seedings, and those from June seedings were only 9 days less than from May seedings.

The greater reduction in number of days from seeding to maturity in April as compared with March seeding was caused by greater temperature differences that occur between April and later seeding dates. The further reduction obtained from May and June seedings probably was largely the result of photoperiodic response. Be-

TABLE 12.—*Average days from seeding to first heading of 6 rice varieties representing 4 maturity groups, when sown in each of the 4 months of the planting period in the years from 1953 to 1961*

Maturity group and variety	Time of seeding				Average
	March	April	May	June	
Early:	*Days*	*Days*	*Days*	*Days*	*Days*
Nato	103	88	80	76	87
Midseason:					
Sunbonnet	118	103	98	93	103
Toro	118	102	96	90	102
Medium-late:					
Blue Rose	137	115	102	86	110
R–D	136	121	115	105	119
Late:					
Rexoro	153	137	127	114	133
Average	128	111	103	94	

cause of slow ripening late in the growing season, very late seedings tend to lengthen the life cycle rather than reduce it.

Seven varieties that mature in from 100 to 165 days were sown at four successive dates each year from 1953 to 1961. The response of these varieties is shown in figure 25. The upper part of the curve for each variety, representing the earlier part of the planting period, tended to be steep, because when the weather warmed in the spring, the length of the period from seeding to heading was rapidly reduced. Further reduction in time until heading for five of the seven varieties proceeded at a slower but comparatively uniform

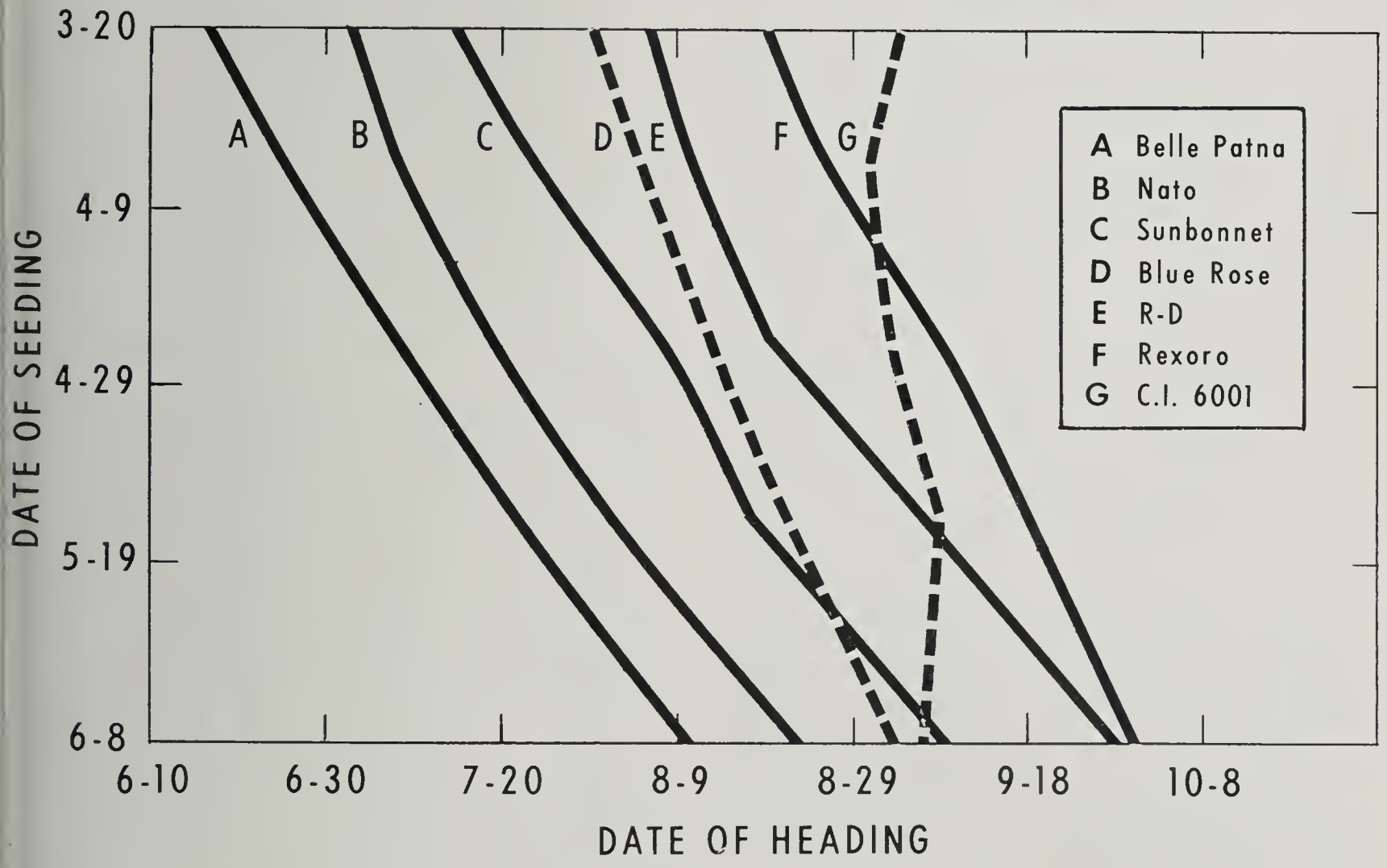

FIGURE 25.—Heading date in relation to seeding date of 7 adapted varieties grown at Crowley, La., from 1953 to 1961.

rate through the remainder of the season. Consequently, the curves indicating the response of those five varieties are roughly parallel.

Blue Rose and C.I. 6001 had steeper curves than did the other five varieties. This reflected greater sensitivity to photoperiod. C.I. 6001 was later than R–D and Rexoro when seeded early but became earlier from subsequent seeding. Blue Rose was later than Sunbonnet when seeded early but became earlier from subsequent seeding.

Early-maturing varieties do not show the characteristics of photoperiodic response, otherwise they would not head during the long days of June and July. Or possibly the critical length of the dark period is much shorter for them than for the more sensitive later varieties.

All varieties have a vegetative stage of development during which they are not photosensitive. The less sensitive midseason and later varieties may have a longer vegetative stage than do the early varieties.

Sensitive and short-season (early) varieties may be seeded later than less sensitive midseason or late varieties. However, Arkrose and Caloro are the only sensitive varieties now in production. Any of the less sensitive varieties can be used for successive seedings because the plants mature in the order seeded, and the fields can be harvested without conflict.

Data obtained from date-of-seeding experiments may be used to predict time of maturity of rice varieties. This information makes it possible to schedule seedings so that different fields and varieties may be harvested consecutively. The approximate dates of maturity of eight varieties when sown at 10-day intervals, March 1 to June 30, in southwest Louisiana are shown in table 13.

Yields in Relation to Seeding Date.—Average yields of variety groups by monthly seeding dates are summarized in table 14. Production of the early varieties varied but little because of date of seeding. Midseason and medium-late varieties were less productive from June seedings than from earlier seedings. Yields from May seedings of Rexoro and other late varieties were reduced. Yields from June seedings were unprofitably low or were complete failures.

Probably Rexoro should not be seeded after about May 20 at the latest (*40*), and April seeding is preferred. Currently, no medium-late varieties, such as Blue Rose, are in production. These have been replaced by early-maturing, medium-grain varieties. The midseason varieties Bluebonnet 50 and Sunbonnet may be seeded in Louisiana as late as the first week of June with satisfactory results. Nato and other early varieties may be seeded in Louisiana at any time from early March to the end of June with expectation of profitable yields. In some years blast may be serious during the warm humid weather in the summer months. During years when this disease is prevalent, there may be a reduction in stand of late-sown susceptible varieties. There may at the same time be a reduced yield from early-sown, short-season varieties caused by the rotten-neck phase of blast.

Plant Height in Relation to Seeding Date.—Average plant heights of four groups of varieties by monthly seeding ranges are summarized in table 15. Midseason and late varieties were taller than were early varieties. Midseason varieties seeded in June and late varieties seeded in May and June were shorter than when seeded earlier. Adair (*3*) reported that in Arkansas later seedings produced shorter straw, and Beachell (*17*) found a marked reduction in plant

Table 13.—*Approximate dates of maturity of 8 rice varieties when sown at 10-day intervals in southwest Louisiana*

Seeding date	Belle Patna	Gulfrose	Nato	Bluebonnet, Sunbonnet, or Toro	Texas Patna	Rexoro
Mar. 1	7–13	7–25	7–28	8–13	9–8	9–18
10	7–17	7–27	7–30	8–15	9–11	9–20
20	7–22	8–2	8–4	8–22	9–15	9–25
30	7–26	8–4	8–9	8–27	9–21	10–2
Apr. 10	8–2	8–13	8–16	8–31	9–27	10–6
20	8–9	8–21	8–22	9–5	10–3	10–13
30	8–14	8–27	8–30	9–15	10–7	10–19
May 10	8–21	8–31	9–5	9–21	10–13	10–25
20	8–29	9–4	9–15	10–1	10–18	10–30
30	9–5	9–12	9–24	10–11	10–25	11–4
June 10	9–13	9–23	9–30	10–18	11–3	11–15
20	9–26	10–4	10–9	10–25	11–12	(1)
30	10–8	10–16	10–17	11–4	(1)	(1)

[1] Failed to mature.

TABLE 14.—*Average yields of 3 rice varieties in each of 4 maturity groups, from seedings made in each of the 4 months of the planting period in the years from 1953 to 1961*

Time of seeding	Maturity groups				Average
	Early	Midseason	Medium-late	Late	
	Pounds per acre	*Pounds per acre*	*Pounds per acre*	*Pounds per acre*	*Pounds per acre*
March	2,771	2,740	2,634	2,521	2,667
April	2,674	2,744	2,852	2,324	2,649
May	2,604	2,632	2,826	2,172	2,568
June	2,623	2,395	2,452	[1] 1,197	[2] 2,167
Average	2,668	2,628	2,691	[3] 2,054	

[1] Late varieties failed in 1954 and 1957.
[2] Average of June seedings, late group excluded, 2,490.
[3] Average of late varieties, June seeding excluded, 2,339.

TABLE 15.—*Average plant heights of 3 rice varieties in each of 4 maturity groups, from seedings made in each of the 4 months of the planting period in the years from 1953 to 1961*

Time of seeding	Maturity groups				Average
	Early	Midseason	Medium-late	Late	
	Inches	*Inches*	*Inches*	*Inches*	*Inches*
March	43	47	49	49	47
April	44	47	50	49	48
May	44	47	49	48	47
June	45	46	45	45	45
Average	44	47	48	48	

height of varieties that headed in response to a 10-hour photoperiod.

The reductions in average heights from later seedings, as shown in table 15, correspond to reduced yields in the respective months, as shown in table 14.

A correlation of 0.25 between height and yield within individual varieties from seedings in the earlier months indicates that higher yields tend to be associated with greater plant heights from early, medium, or late seeding dates. This does not mean that short-strawed varieties necessarily tend to be low yielding. However, among fields of the same variety, plants with taller straw are likely to be higher yielding than those with shorter straw. Exceptions to this generalization may occcur when nitrogen fertilizer is applied at different times.

MILLING QUALITY IN RELATION TO SEEDING DATE.—Average percentages of head rice from varieties representative of four groups are summarized according to monthly seeding date in table 16. No comparison can be made of the average milling quality of these groups because of the lack of correspondence in grain type of the varieties within groups.

March seeding resulted in low percentages of head rice, probably because of higher temperatures during the maturation period. Ripening is hastened in hot weather, and more chalky grains are produced. Also, rapid changes in temperature and moisture tend to cause checking of the grain. Compared to March seedings, April and May seedings gave improved milling quality. The average percentage of head rice was 3 percent higher from May than from April seedings.

The average percentages of head rice from May and June seedings were equal. However, the midseason and especially the late varieties were lower in milling quality from June seedings, probably because of effects of low temperatures late in the season.

The early and medium-late, medium-grain varieties tended to give increasingly higher percentages of head rice from each successive seeding. Thus, apparently improved milling quality is a major advantage of late seeding.

TABLE 16.—*Average percentages of head rice from samples of 3 rice varieties in each of 4 maturity groups, from seedings made in each of the 4 months of the planting period in the years from 1953 to 1961*

Time of seeding	Maturity groups				Average
	Early	Midseason	Medium-late	Late	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
March	57	53	49	47	52
April	60	56	54	49	55
May	60	61	57	52	58
June	65	59	58	48	58

Production of Seed Rice

By T. H. JOHNSTON

Origin of High-Quality Seed Rice

According to Wise (*88*), new and superior varieties of crops make their intended contributions to agriculture only "when the seed stocks of such crops reach the farmer varietally pure, in a viable condition, free of noxious weeds, in adequate quantities and at a reasonable price."

To produce this high-quality seed, a grower must have a source of superior seed of a well-adapted variety. Promising new strains are compared to standard varieties continually at the rice experiment stations to determine their adaptation. When an experimental strain proves to be superior to standard varieties, it is increased for release to growers.

Formerly each farmer could obtain a small amount of seed of a new or standard variety and thereafter produce his own seed. However, modern harvesting and processing methods, including bulk drying and storage, have increased the possibility of mixing. These methods and the use of more specific types of varieties that differ in maturity, grain type, and processing and cooking quality have emphasized the need for sources of pure seed. As a result, the seed certification program now in effect in each major rice-producing State is an important part of the rice industry.

"Minimum Seed Certification Standards" (*36*) states:

> The purpose of Seed Certification is to maintain and make available to the public sources of high quality seeds and propagating materials of superior varieties so grown and distributed as to insure genetic identity. Only those varieties that contain superior germ plasm are eligible for certification. Certified seed is high in varietal purity and of good seeding value.
>
> Varieties eligible for certification have resulted either from natural selection or through systematic plant breeding. In either case without a planned method of maintaining genetic purity, there is grave danger of losing varietal identity.
>
> Varietal purity is the first consideration in seed certification but other factors, such as weeds, diseases, viability, mechanical purity and grading are also important. One of the most effective methods of preventing the wider distribution of weeds is to plant weed-free seed. Adverse effects of plant diseases can be reduced by planting clean seed from disease-free fields. Properly cleaned and graded seed is easier to plant and gives more uniform stands.
>
> Seed certification is designed, therefore, to maintain not only the genetic purity of superior crop varieties, but also reasonable standards of seed condition and quality.

It also is stated in this publication:

> Only those varieties that are approved by a State or Governmental agricultural experiment station and accepted by the certifying agency shall be eligible for certification.

In general, before a variety is approved by an experiment station, it must be tested thoroughly (usually for a minimum of 3 years), and it must show merit as a new variety in production, disease resistance, or some other outstanding character.

Classes of Seed in a Certification Program

The classes of seed usually included in a certification program are breeder, foundation, registered, and certified. These are described by the International Crop Improvement Association (*36*) as follows:

(1) *Breeder seed* is seed directly controlled by the originating, or, in certain cases, the sponsoring plant breeder or institution, and which provides the source for the initial and recurring increase of foundation seed.

(2) *Foundation seed* shall be seed stocks that are so handled as to most nearly maintain specific genetic identity and purity and that may be designated or distributed by an agricultural experiment station. Production must be carefully supervised or approved by representatives of an agricultural experiment station. Foundation seed shall be the source of all other certified seed classes, either directly or through registered seed. White tags are used to designate this class of seed.

(3) *Registered seed* shall be the progeny of

foundation or registered seed that is so handled as to maintain satisfactory genetic identity and purity and that has been approved and certified by the certifying agency. Purple tags are used to designate this class of seed.

(4) *Certified seed* shall be the progenies of foundation, registered; and, in some cases, previously certified blue tag seed that is so handled as to maintain satisfactory genetic identity and purity and that has been approved and certified by the certifying agency. Blue tags are used to designate this class of seed.

For the production of the various classes of certified seed, it is necessary to have clean land and to prevent mixtures in seeding, harvesting, and processing. Although careful roguing of all fields to remove undesirable weeds, other crops, or offtype plants increases the production costs, it is necessary.

The production of breeder and foundation seed is an integral part of the cooperative rice-breeding projects of the U.S. Department of Agriculture and the Agricultural Experiment Stations. The production and certification of registered and certified seed are not a part of the breeding program.

Breeder Seed Production.—After an experimental variety of rice has been developed in the coordinated breeding program and has been proved sufficiently outstanding, procedures are begun to purify it and to provide a seed supply for possible release to growers for commercial production.

Procedures differ at the various experiment stations but the steps included usually are somewhat as follows: (1) From 100 to 500 panicles are selected from the interior rows of nursery or field plots of the experimental variety; (2) these panicles are weighed and the weight is added to the plot weight so as not to cause inaccurate plot yield reports; (3) each panicle is inspected and any having offtype seeds is discarded; (4) each panicle typical of the variety is threshed individually; and (5) the seeds are placed in a small envelope.

The following year the seed from each panicle that passed the screening test is sown in a single row from 4 to 20 feet long and 12 to 24 inches apart. In some cases there are 3-foot alleys between ranges of rows to facilitate careful inspection and roguing. The block of panicle rows of each variety is isolated from those of varieties similar in maturity so as to eliminate natural crossing and subsequent segregation for offtypes.

After the seedlings emerge, they are carefully inspected at intervals to identify any offtype plants or rows. Rows that show offtype plants or any apparent differences at any stage are removed immediately or tagged for removal before harvest. In the early seedling stage, special emphasis is given to noting albino seedlings or variable plant types. Later in the season special attention is paid to uniformity of vegetative growth and heading within and among rows. During the ripening period, careful observations are made to detect differences in plant type, plant height, panicle type, pubescence, color of apex or apiculus, and grain type. If the entire group of panicle rows appears uniform, the rows are harvested in bulk.

However, if considerable variability attributed to genetic segregation is evident or if numerous offtype plants are found, then it may be necessary to make further selection of rows for purification. This may be done by selecting from within a block of rows individual rows that appear to be uniform in appearance and that typify the variety being increased.

The grain from 30 to 50 or more such rows (families) may be harvested separately after 25 to 100 panicles are selected from each row. A number is assigned to each family for maintaining its identity. The following year, from 10 to 20 or more rows may be sown from the bulk seed of each family, or a similar number of panicle rows from panicles saved from each family row may be used instead of the bulk.

An alternate method would be to select a few panicles from all rows that appear to be typical of the variety and grow three to six panicle rows of each row.

The panicles saved from each family row are examined individually for offtypes and are grown by seeding each family in a group or block of 3 to 25 or more panicle rows. As before, the rows are observed for offtype or undesirable type plants in the seedling and later stages. If several offtypes are found within a family or if the rows within a family tend to be variable or are not typical of the variety, the entire family may be eliminated. If there still appears to be too much variation in the material, it may be necessary to again select individual rows from families most similar in plant type. Several rows may be selected from each of several families, again identifying the families and subfamilies, and the subfamilies grown in panicle-row blocks the following year. Usually at this stage the material is sufficiently uniform, so that there are only a few offtypes to discard or eliminate.

If a variety needs to be released as soon as possible because of a disease emergency, for example, one procedure would be to increase and release seed at an earlier stage and at a designation lower than foundation seed. Purification of the variety could be continued and foundation seed could be released as soon as it becomes available.

It may be desirable to check the processing and cooking quality of the bulk seed from each

family row used in the purification increase. Useful quality tests are the alkali digestion (*65*) and iodine-blue tests (*34*). The final bulk representing all the family lines should be grown in variety trials to determine the overall performance of the mass-selected strain.

One method used to produce breeder seed of established varieties is to select panicles from the best available source of seed of that variety, such as a field being grown for production of foundation seed. Depending on the facilities available and the amount of seed desired, individual panicles may be selected in quantities varying from 500 to possibly 5,000. These panicles are carefully inspected and those that are typical for the variety are threshed individually and head rows are grown (fig. 26).

One procedure that has helped to eliminate

FIGURE 26.—Breeder seed head-row block.

natural crosses with other varieties has been to seed the block of breeder panicle rows within the area of a foundation field of the same variety. Each row must be examined carefully throughout the growing season and atypical rows eliminated. Failure to eliminate a row with a few offtype plants will adulterate the seed produced, and it must be discarded. Typical rows are bulked. The family method described for selecting new varieties may be necessary if a commercial variety becomes badly mixed. But this method should be used as a last resort, since severe mass selection may result in genetic alteration of the original variety.

An alternate method used for the production of breeder seed of established varieties is to start with the best source available and, depending on the amount of breeder seed desired, to carefully handpick a given quantity of seed to eliminate grains that appear to be offtype or to have other undesirable characteristics. This handpicked seed can be drilled thinly, possibly at one-fourth

the normal rate, in rows 50 to 150 feet long, spaced 12 or more inches apart. This increase block then is observed very carefully at intervals throughout the growing season, and offtype plants are eliminated. This method is much less time consuming than the panicle-row method and appears to be quite satisfactory for well-established varieties that have been purified several times previously. This method may be preferred to the panicle-row method, since there is less chance of genetic alteration.

A system that was inaugurated at Beaumont, Tex., in 1962 may eliminate growing breeder seed panicle rows of a variety after a pure source of breeder seed is established. Under this system the plant breeder produces a fairly large quantity of seed from panicle rows or family blocks that is true to type for the variety. This seed is cleaned and put into 50- to 100-pound containers and is placed in storage under conditions suitable for maintaining the viability for at least 10 years. One or more units from storage can be sown each succeeding year to produce foundation seed.

The advantage of this method is that once a variety is purified, a continuing source of seed of known purity is available. To carry this system one additional step, a portion of the seed used to produce the seed for storage is saved and stored under conditions suitable for retaining the viability for more than 25 years. Each 5 to 10 years, or as needed, a portion of this remnant seed may be sown to produce another supply of breeder seed identical to that originally stored.

Foundation Seed Production.—Foundation seed usually is the first year increase from breeder seed. Foundation seed is produced on fields that have not grown another variety or a lower class of the same variety during the 2 previous years. Preventing mixtures throughout the various phases of seed production requires very close attention when several varieties are handled with the same equipment. To facilitate roguing of foundation seed fields, a space is left every few feet by stopping up one or more of the holes in the farm-type grain drill used for seeding. Such fields should be rogued several times during the last part of the growing season. Insofar as possible, foundation seed fields are managed to produce satisfactory grain yields without excessive vegetative growth and to minimize lodging. It is impossible to satisfactorily rogue a field in which an appreciable amount of lodging has occurred.

The release of foundation seed to growers usually is handled through a committee or seed council or similar organization that allots the seed to carefully selected growers, often on the basis of rice acreage within a county or parish. Sometimes the seed is turned over to a seed growers' organization or crop improvement association. Sometimes foundation seed is distributed directly to growers from the State agricultural experiment station. For new varieties or for old varieties in short supply, requested amounts of seed may be reduced in proportion to the amount that is requested.

Cleaning, Grading, and Processing Seed Rice

Cleaning and processing seed rice is an exacting operation that requires specialized equipment. Where conditions and facilities permit, it is desirable to delay harvesting seed rice until the moisture content is below 20 percent. If the combine harvester is carefully adjusted, the rough rice coming from "clean" fields may be relatively free of stems, weed seeds, and trash so that it can be unloaded and safely elevated directly into aerated bins without prior aspirating or scalping. In such case the seed rice is placed in hopper-bottom bins and aerated with an excess of air to dry the grain or at least keep it from heating. Where necessary, the air may be heated to facilitate drying of the seed rice to a moisture level sufficiently low for safe storage. If rice coming from the field contains considerable foreign material, it may be advisable to partly clean it with a scalper-aspirator machine before putting it in the bin for aeration. In some locations, facilities and conditions require that the rough rice be dried before it can be safely stored. This drying may require that the rice be passed through the drier several times. Frequently the rice is aspirated between passes to remove foreign matter and light-weight, immature grains. Extreme care must be exercised to prevent mechanical mixing if the drying and cleaning facilities are used for more than one variety of rice.

The first step in the cleaning and grading process is to put the rice through a fanning mill, which has the following parts: (1) a wind aspirator that removes light grain, hulls, and other light-weight foreign material; (2) a screen with large perforations that removes any remaining sticks, stems, mud lumps, or large weed seeds; and (3) a finely perforated screen that removes the finer broken rice grains, small weed seeds, and other small particles of foreign material. It may be necessary to put the rice through the cleaner a second time to remove less easily separated material such as shelled rice grains and weed seeds or an excess of light-weight, underdeveloped grains.

The next step is a grain-length separation that may be accomplished either by a disk or an indented cylinder-type machine. Small pockets or indents in revolving disks or cylinders retain the shorter length grains (including broken grains and hulled grains) slightly longer while the grain is lifted by the revolving disk or cylinder. A

special compartment collects and eliminates the rejected material from the grain.

The third step in the cleaning and grading process is a diameter or width separation that removes any large diameter rice grains, weed seeds, or foreign materials. For this operation either a vertical screen or a perforated cylinder grader is used. The grains of normal diameter pass through the screen perforations while the grains of larger diameter, the weed seeds, or foreign materials are retained and thus removed from the sample. For successful length and width separations, the sample should be free from sticks, stems, and other foreign materials because such materials will interfere with the proper functioning of the machine.

The length and diameter grading of seed rice has been extremely useful in removing the larger diameter red rice grains from seed of long-grain varieties. The use of these graders has been important in the control of red rice. In medium- and short-grain varieties, the only means of red rice control is the use of red rice free seed and land, since no economical method of separation has as yet been devised. In some instances long-grain red rice types have occurred in the long-grain varieties. Whenever a lot of long-grain seed rice has a mixture of long-grain red rice, it should be discarded immediately and not used for seed. The propagation of seed containing long-grain red rice will soon result in a wide infestation of the soil with long-grain red rice strains and will further complicate the maintenance of pure seed production.

Following the diameter-grading operation, the seed rice usually is treated with a fungicide and often with an insecticide and placed in well-marked 100-pound bags. The seed is then ready for distribution to selected growers.

Each of the rice experiment stations has a plant for processing seed rice. These plants are designed to make the installations as nearly self-cleaning as possible. They are being constantly improved as new and improved equipment and methods are developed. Gravity movement of bulk seed is used whenever possible. Steel or metal-lined bins with smooth walls and gravity flow metal hopper bottoms simplify cleaning the facilities. Belt conveyors are preferred to other types because of ease of cleaning.

The seed rice processing plant at Stuttgart, Ark., was described by Williams (*86*). It includes a concrete dump pit, a truck hoist, a 60-hundredweight-per-hour drier, two bucket-type elevators, ten 450-hundredweight bins, two half-size working bins, cleaning equipment, a seed treater, and 3,500 square feet of sack storage space (fig. 27). In addition, seven 35-hundred-

FIGURE 27.—Rice seed processing plant at Stuttgart, Ark.

weight bins are available for small lots of breeder seed. All bins are of steel construction and are equipped with aeration.

Small portable cleaning units without elevators or conveyors frequently are used for cleaning small lots of breeder seed. These small lots usually are dried on sack driers or small laboratory driers to further reduce hazards of mixing. Various sizes and types of seed-cleaning and handling equipment are described in detail by Harmond, Klein, and Brandenburg (*35*).

Standards for Seed Certification

The standards for field inspection and laboratory analysis of seed samples for seed certification are summarized in tables 17 and 18. These reflect the ranges in the standards for the seed certification agencies in the Southern States of Arkansas (Arkansas State Plant Board), Louisiana (Louisiana Department of Agriculture and Immigration), Mississippi (The Mississippi Seed Improvement Association), and Texas (The State Seed and Plant Board, Texas Department of Agriculture), and in California (California Crop Improvement Association).

In some States lots of seed that contain seed-transmissible diseases will not be certified, and in other States lots of seed of this type must be reported.

In order for the rice to be eligible for certification, the seed rice field must not have had another rice variety or the same variety of lower class growing on it the previous 2 years. The field also must be isolated from other ricefields. When the seed rice field is drill seeded, the minimum isolation distances range from 10 to 29 feet with a ditch, fence, roadway, or other definite boundary. When the field is sown broadcast with ground equipment, the minimum isolation distance is 50 feet. When the adjoining field is seeded by airplane parallel to the seed rice field, the minimum isolation distance is 100 feet. When adjoining fields are seeded by airplane at right angles to the seed rice field, the minimum isolation distance is one-fourth mile. In California, all ricefields that are to produce certified seed must be marked before April 15 at the corners and at one-fourth-mile intervals by red or other vivid colored flags that are 3 feet square.

Specific requirements and standards are established for each State and a list of these is available from each of the official certifying agencies. In general, they are concerned with application procedures, field and harvest inspection, post-harvest seed movement, seed processing, and official sampling.

TABLE 17.—*Ranges among major ricegrowing States in standards for field inspection of rice for 1962*

Factor	Standards for each class		
	Foundation	Registered	Certified
	Per acre	*Per acre*	*Per acre*
Other varieties – definite	0	0 to 160 plants	10 to 200 plants.
Other varieties – similar grain type	0	Up to 160 heads	Up to 480 heads.
Curly indigo and other highly objectionable weeds	0	0	0.
Red rice	0	0 to 8 plants	0 to 18 plants.

TABLE 18.—*Ranges among major ricegrowing States in standards for cleaned seed of rice for 1962*

Factor	Standards for each class		
	Foundation	Registered	Certified
Pure seed (minimum)	98 to 99 percent	98 to 99 percent	98 to 99 percent.
Other varieties – definite (maximum)	0	0 to 1 per 5 pounds	3 per 5 pounds to 5 per pound.
Other varieties – doubtful (maximum)	0 to 7 per pound	0 to 10 per pound	0 to 20 per pound.
Other crop seed (maximum)	0 to 1 per pound	1 to 2 per pound	2 to 5 per pound.
Curly indigo, coffeebean, field bindweed	0	0	0.
Other noxious weeds (maximum)	0	0	1 in 2 pounds.
Red rice (maximum)	0	0 to 1 per 2 pounds	0 to 1 per pound.
Total weed seed (maximum)	0 to 0.05 per cent	0 to 0.1 percent	5 per pound to 0.1 percent.
Inert matter (maximum)	1 to 2 percent	1 to 2 percent	1 to 2 percent.
Germination (minimum)	80 to 85 percent	80 to 85 percent	80 to 85 percent.
Moisture (maximum)	14 percent	14 percent	14 percent.

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SOILS AND FERTILIZERS

By D. S. Mikkelsen and N. S. Evatt

Types of Soils Used for Rice Production

Rice, a semiaquatic plant, must be maintained under flooded conditions during part or all of the growing season to minimize weed competition and to provide high yields. Because of these water requirements, the ideal soil types for rice production are those that conserve water. Usually clay and clay loams, silty clay loams, or silt loams are considered most desirable. Soils with a high clay and silt content provide conditions for slow water percolation. Other soils, including organic soils, can be used if they possess a hardpan or claypan capable of maintaining up to 8 inches of floodwater. Rice soils should be capable of easy surface drainage also, since many aspects of mechanization require removal of the surface water.

Apart from the aspects of water conservation, light-textured clay and silt soils are generally preferred because of their generally favorable fertility and chemical and physical properties conducive to the satisfactory growth of rice. These soils, when drained, adequately support the mechanical equipment used in rice production. Soil requirements for rice are not demanding, but the soil should be fertile and capable of satisfactory management.

Rice does not have a critical soil pH requirement, although the best producing soils have values between 5.5 and 6.5. In this range of pH values, nutrient availability is generally good; and toxicities from such things as aluminum, iron, sulfides, and sodium do not generally occur. The soil pH in the rice root zone normally increases from 0.5 to 1.5 pH units when placed under flooded conditions, and it decreases when the excess water is removed. This increase of pH influences the uptake of nutrients and plant development. Use of some fertilizers, particularly prolonged use of ammonium nitrogen sources, increases soil acidity. It is not uncommon for soil pH to decrease as much as 2 pH units where ammonium nitrogen sources have been used in rice production for 15 to 20 years.

Salinity problems are sometimes encountered in areas where soluble salts have accumulated or where a poor quality of irrigation water is used. Sea water that is intruded into rivers and waterways or that is brought in by storms of hurricane force may be a source of excess salinity. Because rice can grow in flooded soils, it is occasionally used as a reclamation crop. Varieties differ in tolerance to salinity, but all are affected by the salt concentration of the soil solution in the root zone. The effects of salinity on rice depend somewhat on its stage of development when it is exposed to saline conditions. Studies of salinity effects indicate that rice is most tolerant during germination and is most sensitive during the 1- to 2-leaf stage. Salt tolerance apparently increases during the tillering and elongation stages but decreases during the flowering stage. Results of field experiments have indicated that high soil salinity occurring at planting time may seriously impair yield by reducing germination and stand establishment.

Most rice soils, often referred to as heavy soils because of their high clay and silt content, present special management problems. These include tillage and seedbed preparation, maintenance of organic matter and soil structure, adequate drainage for essential mechanized rice operations and for other crops planted in rotation, green manure crops, fertilizer application, and weed control. Management of rice soils is discussed in the section "Culture," p. 74.

The soils most widely used in rice production in the United States are of alluvial origin (*32*).[1] Brief descriptions of the soils used for rice in the principal rice-growing States are given below.

Arkansas

Crowley silt loam, Calhoun silt loam, and Sharkey clay are the principal soils used for rice production in Arkansas (*21*). Other soils are sometimes used.

Crowley Silt Loam.—The surface of Crowley silt loam is gray to brown. It is underlain with a gray or yellowish-gray silt loam that changes with depth into a gray silty clay and finally into a heavy clay usually mottled with yellow and red. Crowley silt loam in its virgin state has a fairly high organic matter content, but it is low in phosphorus and is strongly acid.

Calhoun Silt Loam.—Calhoun silt loam is a

[1] Italic numbers in parentheses refer to Selected References, p. 72.

light gray to almost white shallow soil underlain with a compact drab or yellowish-drab clay. This soil is common in lowlands in eastern Arkansas. Calhoun silt loam is low in total nitrogen and phosphorus, and it is acid to strongly acid. Rice is commonly grown on Calhoun silt loam in the "North-end" of the Arkansas rice area.

Sharkey Clay.—The surface soil of Sharkey clay is a dark, drab, or grayish-brown silty clay usually mottled with brown. This is underlain at varying depths with a drab, steel-gray or blue, sticky clay. Sand is frequently found in the surface layer. Sharkey clay occurs commonly in the Mississippi River bottoms. It is known as "buckshot land" because it granulates and forms a crumb structure. It can be plowed when wet; and as it dries out, it breaks down into granules or into clods that are easily slaked by rain. Under natural conditions this soil is poorly drained, and the natural vegetation is hardwood and cypress. In the virgin state it is well supplied with nitrogen and phosphorus, and it is slightly acid to neutral in reaction. In recent years, Sharkey clay has been widely used for rice in the Mississippi Valley.

Other Soils.—Other soils sometimes used for rice production in Arkansas are Waverly silt loam, and Waverly, Miller, and Portland clay soils. Because these soils usually have poor natural drainage, they have come into use for rice production only in recent years.

Louisiana

According to Walker and Miears (*35*), the principal soils used for rice production in Louisiana are the Crowley, Midland, and Beaumont soils.

Crowley Soils.—Soils of this type found in Louisiana are the same as soils of this type in Arkansas.

Midland Soils.—The Midland soils, which generally are alluvium deposited by the Red and the Mississippi Rivers, are deep and poorly drained (*5*). The surface soil is gray to dark gray and strongly acid. The subsoil is strong-brown to light olive-brown, heavy, silty clay mottled with gray. It is very strongly acid to mildly alkaline.

Midland-Crowley Mixed Soils.—Soils that are a mixture of Midland silt loam, Midland silty clay loam, and Crowley silt loam are used for rice in Louisiana. Fertility and organic matter content of the soils are moderate, and surface runoff, infiltration, and permeability are slow (*5*).

Beaumont Clay.—Beaumont clay soil is acid, poorly drained, and very slowly permeable (*28*). It occurs mainly in southwest Louisiana and in Texas, east of the Trinity River.

Texas

In addition to Beaumont clay soil which comprises about one-fourth of the riceland in Texas, rice is grown on Lake Charles clay, Bernard clay loam, Edna fine sandy loam, Hockley fine sandy loam, and Katy fine sandy loam (*28*).

Lake Charles Clay.—Lake Charles clay is the principal heavy soil in the rice belt west of the Trinity River in Texas. It comprises probably one-third to one-half of the rice acreage around Houston, Angleton, Bay City, and El Campo. Lake Charles clay is darker and more granular than Beaumont clay. It is slightly acid to mildly alkaline in reaction, with a pH of 6 to 8.

Bernard Clay Loam.—Bernard clay loam is similar to Lake Charles clay but is more loamy and slightly less dark, and it occurs on slightly higher elevations. It is found both east and west of the Trinity River in Texas. This soil is slightly acid to neutral in reaction, with a pH of 6 to 7.

Edna Fine Sandy Loam.—Edna fine sandy loam has a grayish, sandy surface and is underlain at a depth of 6 to 12 inches by a heavy, gray claypan. It is found principally in the western and southwestern parts of the Texas rice belt.

Hockley Fine Sandy Loam.—The Hockley soils form a narrow belt along the northern part of the rice area from Cleveland, in Liberty County, westward through Hockley, Sealy, and Eagle Lake to western Victoria County, Texas. These sandy loam soils are underlain by friable, sandy clay subsoils. They are slightly more sloping and better drained than are the Katy soils, and they require more irrigation water than do the Katy soils.

Katy Fine Sandy Loam.—Katy fine sandy loam occurs in large level areas adjacent to Lake Charles soils and in the flatter portion between the slightly more sloping and better drained Hockley soils.

California

Stockton and Sacramento clay (*27*) and Willows (*14*) are the principal soils used for rice production in California. However, several other soils are also used.

Stockton Soils.—Stockton adobe clay is one of the principal soils used for rice culture in California. The surface soil is dark-gray or black clay, 5 to 16 inches deep. When wet, it is dense and plastic, but it shrinks in drying and develops large blocks separated by wide cracks. The upper part of the dark, grayish-brown, heavy clay subsoil is similar in structure and consistency to the surface soil but is calcareous. The subsoil has slightly more colloidal clay and less organic matter than the surface soil.

Sacramento Soils.—Sacramento clay soil occupies low-lying flood plains and is derived from transported material of mixed geological origin. It was developed under poorly drained, marshy conditions. The dark-gray or dark, brownish-gray surface soil, 14 to 24 inches deep, is coarse and lumpy. It is heavy textured, and contains varying quantities of completely or partly decayed organic matter. The transition to a variable subsoil, made up of stratified layers of mineral and organic soil material, is rather abrupt.

Willows Soils.—Willow soils consist of stream sediment, usually reddish or yellowish brown or dark brown, deposited along the courses of minor creeks or in the waters of temporary lakes, and underlain by brown to light-brown, compact and relatively impervious subsoils.

Other Soils.—Other California soils frequently used for rice production include Genevera, Meyers, and Yolo of sedimentary alluvial origin; Marvin, Merced, and Sycamore of mixed alluvial origin; and San Joaquin of granitic alluvial origin.

Chemistry of Flooded Soils

In the production of rice, the benefits of flooding the soil are recognized wherever the crop is grown. Senewiratne and Mikkelsen (*29*) reviewed the literature and provided evidence that flooding enhances foliar development, tillering, and earlier flowering and increases yield of rice when compared with nonflooding irrigated culture. The superior growth of rice under flooded conditions can be attributed in part to the effects of the aquatic environment; but the chemical characteristics of flooded soils are of major importance in the development of the crop.

The most distinguishing characteristic of a flooded soil is the presence of standing water during part or all of the growing season. The layer of floodwater, creating waterlogged conditions, exerts profound changes in the physical, chemical, and biological status of the soil. The immediate effect of flooding is a drastic curtailment of gaseous exchange between the atmosphere and the soil. Water fills the soil pores, reducing oxygen entry and often allowing accumulation of gaseous products of anaerobic decomposition. Carbon dioxide concentrations build up in the flooded soils, together with methane, hydrogen, nitrogen, and various oxides of nitrogen.

Entry of oxygen is not completely restricted but is confined largely to a thin layer of soil at the soil-water interface (*23*). Oxygen arises from gaseous exchange with the atmosphere and as a product of photosynthesis of phytoplankton and hydrophytes.

Pearsall (*24*) and Pearsall and Mortimer (*25*), working with naturally flooded soils and lake muds, determined that there were significant differences between the soil at the soil-water interface and the soil immediately beneath. Floodwater containing some dissolved oxygen maintained a thin surface layer of soil in an oxidative condition with soil color characteristics and physico-chemical and biological properties different from those of the soil beneath. Oxidation-reduction potentials in the oxidative layer exceeded 320 to 350 millivolts at a pH of 5.0 and contained such oxidized chemical radicals as nitrates, sulfates, ferric, and manganic ions. The underlying soil was conspicuous by the absence of oxygen and the concomitant presence of the reduced forms of chemical radicals such as ammonium, ferrous iron, and manganous manganese; nitrogen gas and its oxides; and various sulfides, including hydrogen sulfide. The oxidation potentials were generally below 350 millivolts at a pH of 5.0 in the reducing layer. Mikkelsen and Finfrock (*17*) showed that reducing conditions in Stockton clay develop about 3 days after a soil is flooded. Patrick and Sturgis (*23*) showed that when soils are flooded, the soil oxygen disappears within a few hours and may be nearly absent at depths exceeding about one-half inch.

The oxidation-reduction status of the soil under flooded conditions is governed by several factors, including the rate of oxygen exchange, microbial activity, the soil content of decomposable organic matter, and the base saturation status.

Flooding has been shown to increase the soil pH. The increase depends partly on the initial pH value and organic matter content of the soil, and on the period of submergence. The pH increase varies usually between 0.5 and 1.5 pH units. Reed and Sturgis (*26*) showed that the pH increase in flooded soils they studied varied from 0.82 to 1.55 pH units, depending on soil conditions and initial pH values. Generally, soils with a low pH and with high soil organic matter composition undergo the greatest pH changes when flooded. The cause of the pH increase is not completely understood but has been attributed variously to increased ammonium composition, soluble ferrous, and manganous hydroxides, which neutralize the exchangeable hydrogen ions in the soil.

Another generally observed result of flooding is the increased specific conductance of the soil solution. The phenomenon is well established, but detailed information is lacking on the specific nature of the increased composition of dissolved solids in the soil. The increase in the concentration of ammonium, iron, and manganese ions, and in the bases displaced by these ions from the soil exchange complex may in part

account for the increased specific conductance. The increased composition of carbon dioxide, especially at high pH values, would increase the bicarbonate ion concentration.

Several mechanical properties of soils, including permeability, plasticity, cohesion, and consistency, are changed by flooding. Ordinarily, these changes do not adversely influence the growth of rice. Allison (*2*) showed that the permeability of a flooded soil is influenced by the amount of air entrapped during submergence. He noted that permeability decreased after flooding but increased again as air trapped in the soil was released. At a later period after flooding, permeability may again decrease if bacteria-produced material blocks the pores and restricts water movement.

Sturgis (*31*) called attention to possible deleterious effects of flooding on soil structure. He cited evidence that low productivity of some Louisiana soils was caused by deflocculation during flooding. The specific factors associated with the deflocculation were not reported.

In addition to other effects, flooding has an important influence on soil temperature and consequently affects the growth of rice both directly and indirectly. The high specific heat and high heat of vaporization of water prevent its temperature from dropping as fast or as low as does air temperature. Under some circumstances, this modification of the plant environment may enhance the growth of rice.

Upland soils with good aeration usually maintain diverse populations of microflora and microfauna. These organisms decompose organic matter from which they derive energy and liberate carbon dioxide. They exert a heavy demand for nutrients, especially nitrogen, as they produce cellular material. Under flooded conditions, the normal soil complement of actinomycetes, fungi, bacteria, algae, and protozoa is modified to produce a microflora consisting principally of anaerobic bacteria, some facultative anaerobes, and a modified population of algae. The anaerobic forms have a much lower energy requirement than do the aerobic forms and consequently decompose organic matter at a slower rate. The slower decomposition of organic matter under flooded conditions is partly responsible for the development of peat in bogs and marshes. The modification in the soil microflora and microfauna is only temporary, and normal populations develop when drainage and aeration are maintained.

The decomposition of organic matter proceeds at a slower rate in flooded soils than in upland soils, and the end products are different. Tenney and Waksman (*33*) showed that the decomposition of cornstalks under flooded conditions proceeds at about half the usual rate; and with more resistant materials, high in lignin, decomposition under flooded conditions is delayed to a much greater extent. In well-drained soils, the end products of organic matter decomposition are principally carbon dioxide, nitrates, and sulphates. Under flooded conditions, the end products include methane, hydrogen, various organic acids, ammonium ions, nitrogen and its various oxides, amines, mercaptans, and hydrogen sulfides.

The rate of organic matter decomposition in soils depends on the kind of organic constituents and their nitrogen content and the carbon-nitrogen ratio. Ordinarily, if nitrogen is adequate for microbial function, nitrogen is mineralized, and if carbonaceous materials are in excess, nitrogen is immobilized. Data from various sources indicate that organic matter decomposition under anaerobic conditions proceeds at lower total nitrogen values than the 1.2- to 1.5-percent nitrogen values established under aerobic conditions and that immobilization of nitrogen does not occur except at higher carbon-nitrogen values than the approximate 15:1 established for well-drained soils. In well-aerated soils, the mineralization of organic matter gradually increases nitrate production. In flooded soils, the mineralization process produces ammonium ions. The number of ammonium ions reaches a plateau value rather rapidly and then declines rather sharply.

The occurrence of two distinct layers—an oxidative layer at the soil-water interface and a reduction layer immediately beneath—exerts a significant influence on agronomic factors associated with rice production. These layers should be taken into account in seedbed preparation, crop residue management, fertilization, cultivation, and water management.

Two types of nitrogen transformations occur in flooded soils, depending on whether oxidizing or reducing conditions prevail. In the thin oxidizing layer at the surface, the nitrogen transformations are similar to those that occur in well-drained soils. Organic matter in this layer is mineralized to ammonium ions and ultimately to nitrate ions by the action of highly specialized autotropic micro-organisms. The nitrate ions are used by either plants or micro-organisms. They may be immobilized, depending on the carbon-nitrogen ratio of the organic matter; or they may be moved into the underlying reducing zone by leaching. The nitrogen status of the reducing zone is characterized by the denitrification of nitrates and the accumulation of ammonium ions. The ammonium ions that are produced by the more sluggish bacterial microflora are not reduced and provide the reservoir of nitrogen for use by the rice crop. Nitrates that move into or originate in this layer are reduced to nitrites and finally to nitrogen gas or its oxides. These gases ultimately escape into the air. This reduction of

nitrates is favored by low oxygen tensions and the presence of oxidizable organic matter. Janssen and Metzger (*10*) have amply demonstrated that nitrate nitrogen accumulates in well-drained soils, in contrast with flooded soils where ammonium ions accumulate.

The practical significance of the differentiation of distinct oxidation and reduction layers is apparent in results demonstrating the poor efficiency of nitrate-nitrogen fertilizer sources in continuously flooded soil and the desirability of fertilizer placement of ammonium nitrogen sources (*20*). Nitrate nitrogen that is applied as a basal fertilizer application or that develops in the oxidation layer is largely lost through leaching and subsequent denitrification. Where reducing conditions develop after flooding, drilling ammonium nitrogen several inches into the soil before flooding provides good retention and availability of the nitrogen for the rice crop (*17*).

Flooding a soil often provides conditions for the increased availability of both the native phosphorus and that applied as fertilizer. Evidence of this is obtained in both the uptake of phosphorus by rice and the increased solubility of phosphorus, as shown by soil-test extraction methods (*13*, *20*, *30*). Factors that appear to be associated with increased phosphorus availability include pH modification, reduction of insoluble ferric phosphate to the more soluble ferrous form, hydration and subsequently increased hydrolysis of ferric and aluminum phosphates, and increased displacement of soluble phosphorus by formation of complex ion and substitution of organic anion.

Sulfur in organic forms or as the sulfate ion is ultimately reduced, at least in part, to sulfides in flooded soils. Sulfate reduction is accomplished by anaerobic bacteria that are active over a wide range of soil pH and operate under low oxidation-reduction potentials. Hydrogen sulfide, the end product of bacterial reduction, may occur free in gases produced in flooded soils and may accumulate in amounts toxic to rice. This occasionally occurs in light-textured soils under extreme reducing conditions and in the presence of large amounts of readily decomposable organic matter. Normally, soils contain sufficient active iron to completely precipitate the sulfide ion as ferrous sulfide.

Iron, a prominent constituent of the soil, occurs in primary minerals, hydrated oxides, silicate clays, and various organic complexes. When a soil is flooded, the iron undergoes considerable changes in solubility, which is greatly influenced by anaerobic bacteria. The extent of the change is also a function of the organic matter content, the low oxidation-reduction potential, and the soil reaction. Ferric iron, which predominates in well-drained soils, is reduced to the ferrous form, especially as hydroxides and carbonates. Decomposable organic matter in the soil enhances the reduction process. With sustained flooding, equilibrium develops between the soil and the soil solution, with a significant increase in soluble and exchangeable iron. Both mineral and organic salts of iron appear in the soil solution. Ordinarily, the abundance of soluble iron does not adversely affect the growth of rice; but situations may exist where toxicities or nutrient antagonism may impair growth.

Manganese chemistry of the soil is not well understood. Its forms are dynamic in equilibrium, depending on such factors as pH, oxidation-reduction status, the presence of organic matter, and microbial activity. Manganese occurs in three valence forms, with some compounds containing manganese in two valence forms. In some respects, the behavior of manganese in the soil is similar to that of iron. In flooded soils, the higher oxides of manganese are reduced to soluble and exchangeable ions. Biological reduction occurs independent of soil pH if low oxidation-reduction potentials exist. Decomposing organic matter reduces manganese, especially in the lower soil pH range. It is unusual for soil manganese in flooded soils to affect growth of rice adversely. High levels of soluble and exchangeable manganese in the soil may be toxic to sensitive crops grown in rotation after rice.

Fertilizers

Southern Rice Area

The proper use of fertilizers on rice increases yield from 30 to 50 percent in the southern rice area. Practically the entire rice area in Louisiana and Texas requires additions of commercial fertilizers for economical yields. This is also true with most of the rice soils in Arkansas, particularly in the traditional ricegrowing area of the Grand Prairie region; however, the newer rice bottomland soils in the delta areas of Arkansas and Mississippi may not require fertilizer during the first year or two of rice cropping.

Commercial fertilizers were not used extensively in the southern rice area before World War II. In fact, results from many of the soil fertility tests conducted in the early thirties showed negative yield responses from fertilizer applications (*12*). This was usually true when various rates and ratios of nitrogen and phosphorus had been applied at seeding. This method of application greatly stimulated weed and grass growth before the rice plants became established, and this competition often severely reduced rice yield. However, the real worth of commercial fertilizers became apparent with the gradual improvement of irrigation and drainage facilities, improved land preparation, mechanized harvesting equipment, the development of varieties suitable for

mechanization, and the greatly increased use of the airplane for applying fertilizers. Fertilizers were also greatly improved. Pelleted or prilled, granular, and large crystalline, high-analysis fertilizers are available and are ideally suited for application with the airplane or with improved ground equipment (*1*, *3*).

Knowledge of previous cropping history and a soil test are useful in determining the amount and kind of fertilizer to use on rice in some Southern States (*4*, *28*). Specific fertilizer recommendations vary considerably between States and from area to area within States, or even from farm to farm within the same area. The rice variety, water management, methods of weed control, and other managerial variables affect use of fertilizers (*15*). Various rapid, chemical, soil-testing methods are used effectively to determine the fertilizer and lime requirements of rice soils (*4*). Chemical determination can be made on soil reaction (pH), percentage of organic matter, and the available phosphorus, potassium, and calcium; and the salinity hazard can be noted. The nitrogen level is usually estimated from the organic matter content. Results of these tests obtained from air-dried soil samples can be interpreted with reasonable accuracy, provided basic information is available on the complex chemical changes known to occur under submergence. All this information is of value in determining fertilizer requirements for rice in southern rice areas.

Nitrogen is used at somewhat higher rates in Arkansas than in the other States. Rates above 100 pounds per acre of actual nitrogen are rather common, particularly on the soils of the Grand Prairie (*34*). Some differences in the fertilizer requirements of rice varieties are recognized, with the stiffer strawed varieties being capable of using and withstanding higher rates of nitrogen without lodging. Phosphorus and potash are usually applied on the basis of a soil test. The nitrogen requirements for rice grown in the delta areas of Arkansas and Mississippi seldom exceed 60 to 80 pounds per acre. These newer soils frequently require no fertilizer during the first year or two of rice production.

The timing of fertilizer application on rice is very important. Most rice farmers in Louisiana and Texas prefer a somewhat earlier application of the total amount of fertilizer than do farmers in Arkansas and Mississippi (*34*). For all States, however, it is generally conceded that all of the phosphorus and potassium and part of the nitrogen should be applied as near to seeding time as possible. In Louisiana and Texas, the remaining nitrogen should be applied before the rice has completed half of its growth period. In Arkansas, a nitrogen application about 60 to 70 days before harvesting has produced good results. Thus, the timing depends to a large extent on the total growth period of the particular rice variety.

The rice soils in Louisiana and Texas are generally deficient in phosphorus and in organic matter (*35*). Thus additions of from 20 to 40 pounds of phosphoric acid per acre and from 40 to 80 pounds of nitrogen per acre are usually necessary for the economical production of rice. In most instances, no potash is required. The small areas of sandy soils in both States, however, sometimes respond to a 20- to 40-pound per acre application of potash.

When applying fertilizer as a topdressing on rice growing in heavy soils, placing it on dry soils is usually preferred to placing it on wet or flooded soils. Soon after the fertilizer is applied, the fields are flooded; thus the water is an effective carrier to move the fertilizer into the root area. If scarcity of irrigation water, weed infestations, rains, or timing difficulties prevent flooding, the rate of application, particularly of nitrogen, is increased slightly to compensate for reduced efficiency. The rate for nitrogen should be increased about 5 to 10 percent on wet soils and perhaps 10 to 15 percent on flooded soils (*28*).

Applying a large amount of fertilizer directly with the seed is hazardous, since germination may be reduced or emergence may be delayed. The time of seedling emergence directly influences the flooding date and thus becomes important in controlling grass weeds. These problems do not ordinarily occur if the fertilizer is placed 2 to 3 inches below the seeds.

Limited research on the mineral deficiency symptoms of rice has been conducted in the United States. Olsen (*22*) reported typical foliar symptoms due to deficiencies of nitrogen, phosphorus, potassium, calcium, magnesium, and iron in three greenhouse experiments. A deficiency of each of these elements, except calcium, reduced tillering. Reduced tillering caused by nitrogen deficiency was particularly pronounced. All elements reduced root and top development; potassium and nitrogen deficiencies caused the most severe reductions.

The sources of nitrogen, phosphorus, and potassium used in southern rice areas vary widely and to a large extent depend on the cost of application and physical condition of the fertilizer.

Ammoniacal forms of nitrogen are generally preferred to the nitrate forms; however, compounds containing both sources, such as ammonium nitrate or mixtures of ammonium nitrate and urea in liquid form, are considered equal on an equivalent nitrogen basis to such materials as ammonium sulfate, ammonium phosphate, urea, and ammonium chloride. Because of the lower cost of application, there is a definite trend toward the use of high-analysis fertilizers. Anhydrous ammonia is a good source of nitrogen for rice, although it is difficult to apply with ground

equipment during wet periods. Application in water is satisfactory only when precise watering methods are used, since uniform distribution of the material depends on having a uniform distribution and depth of water.

Phosphorus is usually supplied in the form of superphosphate (either 20 or 46 percent) ammonium phosphate, or diammonium phosphate. Rock phosphate is sometimes used and is satisfactory.

Muriate of potash (KCl) is the common source of potassium. Only limited quantities of potassium sulfate are used, although it is considered equal to muriate of potash.

In areas where crops preceding rice have been fertilized with phosphorus and potash, residual amounts of these elements may be sufficient for one or perhaps two consecutive rice crops.

Research has been conducted with minor elements; however, no positive effects on yields or milling quality have been reported.

Addition of limestone has not been necessary for rice grown on moderately to slightly acid (pH 5.0 to 6.5) soils. Of equal importance is the fact that no detrimental effects on rice yields have been noted from adding lime, which is usually added at the rate of 1 to 2 tons per acre on crops rotated with rice.

The long growing seasons in southwestern Louisiana and southeastern Texas permit the production of a ratoon or stubble crop, particularly by the earliest maturing rice varieties seeded around the middle of April. Research in Texas (*8*) has shown that for best results, additional nitrogen, usually about three-fourths of the amount applied to the first crop, should be applied immediately after first harvest. This practice consistently gave rice yields that were one-third to one-half as much as the original crop. Ordinarily, fertilizers containing phosphorus and potassium need not be applied, since residual quantities of these elements applied to the first crop fulfill the ratoon requirements.

California

Fertilizers, particularly nitrogen, increased rice yields in the earliest experiments conducted in California, in 1914–16 (*11*). Dunshee (*7*) continued rice fertilizer research, and it was greatly expanded by Davis and Jones (*6*) from 1925 through 1937. They showed that nitrogen fertilizers improved yields significantly on Stockton clay adobe. Applications at the time of seeding were more effective than were later applications. They also reported that phosphate and potassium fertilizers did not increase yields on Stockton clay adobe.

More recent fertilizer research has demonstrated the need for nitrogen on all soils except those on which a good leguminous green manure crop is grown (*18*). Phosphorus fertilizers have increased yields on the brownish-red terrace soils bordering the Sacramento and the San Joaquin Valleys. Some basin soils after years of cropping produce better rice yields when phosphorus is included with nitrogen. In some areas, usually parts of large fields, where alkali salts have accumulated and where the soil reaction exceeds pH 8.5 in a 1:10 soil–water paste, dramatic responses have been obtained from various iron sources (*9*).

Rice was fertilized in California before 1953 by broadcasting either on the dry seedbed before flooding and planting or, more commonly, on the water by airplane after seeding. Fertilizer placement work of Mikkelsen and Finfrock (*17*) demonstrated that nitrogen broadcast on the soil surface or applied to the flooded fields was not used efficiently by rice. Broadcast nitrogen was lost through nitrification and subsequent denitrification. However, ammonium nitrogen drilled 2 to 4 inches into the soil, where reducing conditions developed 3 to 5 days after flooding, remained in the soil and was continuously available to the rice plants.

The time of applying fertilizer before flooding is important, since nitrification is known to be undesirable both before and during flooding. Mikkelsen (*16*) established that nitrification occurs if ammonium nitrogen is drilled into a warm, moist, aerated seedbed before flooding. As much as 60 percent of the ammonium nitrogen can be converted to nitrate in 7 days of typical spring soil temperatures.

Split application of nitrogen, with part placed in the soil before flooding and the rest used as a topdressing during the period of panicle formation, has proved effective in some regions of the world. Topdressing experiments in California rice production have shown no superiority over preplant soil application (*19*). Where the seedbed application of nitrogen was not sufficient to maintain normal color and growth of rice, supplemental applications have been profitable. For effective use of topdressed nitrogen on California rice varieties, the application should be made no later than 50 to 60 days after planting.

Phosphate fertilizer should be applied before flooding, usually simultaneously with nitrogen. Phosphorus does not move appreciably from where it is applied; this makes placement in the root zone of great importance.

The quantity of nitrogen fertilizer used in rice production varies from 30 to 120 pounds of actual nitrogen per acre. This is supplied as one of the commercially available ammoniacal sources such as ammonium sulfate, urea, anhydrous ammonia, or ammonium phosphate sulfate mixtures. On soil low in nitrogen, as much as 80 to 120 pounds of nitrogen per acre (400 to 600 pounds of ammo-

nium sulfate) is often used. Soils of average fertility, producing about 50 hundredweight of paddy rice, usually receive applications of 60 to 80 pounds of actual nitrogen.

On most California rice soils, applications of 40 to 60 pounds of actual P_2O_5 per acre will supply the phosphorus needs of rice. Some residual effects have been observed on subsequent crops, but the carryover from a single application may not be sufficient for best yields during a second year. In areas where phosphorus is needed, the added growth and yield often require that additional nitrogen be supplied. Where rice produces better growth with phosphorus, it is generally advisable that nitrogen rates be increased 25 to 50 percent.

Experiments to determine the best nitrogen sources for rice have been conducted over a long period. Davis and Jones (*6*) compared ammonium sulfate, Ammo-Phos, Leunasalpeter, urea, Ammo Phos Ko, Leunaphos, Calurea, and cyanamide during 1932–36. They concluded that ammonium sulfate was the most profitable. Experiments in which nitrogen from different sources was drilled into the soil before flooding are reported by Mikkelsen and Miller (*19*). In yield comparisons with ammonium sulfate rated as 100, ammonium chloride ranked 97, cyanamide 92, urea 90, aqua ammonia 85, anhydrous ammonia 83, and ammonium nitrate 57. Aqua ammonia and anhydrous ammonia are good nitrogen sources but in loose dry seedbeds they sometimes do not perform as well as do dry materials because of volatilization losses.

Ingebretsen and others (*9*) reported that in alkali spots where rice ordinarily died soon after emergence, broadcast applications of ferric sulfate corrected iron deficiency and produced excellent yields. Subsequent tests with other materials indicated that iron oxide, modified and natural iron sulfides, and ferrous sulfate likewise corrected the deficiency. Usually 125 to 250 pounds of actual iron from these sources corrects the iron deficiency.

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CULTURE

By T. H. Johnston and M. D. Miller

Rice has been grown as a commercial crop in the United States since the latter part of the 17th century. Rice cultural methods used from that time until the present have been reviewed by Adair, Miller, and Beachell (*8*).[1] They traced the evolution of cultural methods from the use of hand labor for clearing timber from the land, for digging canals and ditches, for plowing with a hoe, for seeding, harvesting, and threshing, through the use of animal power (oxen, mules, and horses) for binding and threshing the rice. Then came steam-powered threshers. Today, several large "rice-special" diesel- and gas-powered tractors and self-propelled combines may be used on one farm. Much of the seeding and most of the fertilizing and spraying is now done by airplanes that can cover several hundred acres a day.

Much of the increase in rice production per acre can be attributed to improved cultural methods made possible by the invention and manufacture of the specialized equipment. The major rice areas of the United States are now described as the most highly mechanized farming areas in the world.

Along with improvements in machinery and farming methods have come other innovations, including use of reservoirs for improved water supply and, more recently, underground pipelines to eliminate many open canals.

Rotation or cropping systems; land leveling and seedbed preparation; seed and seeding; irrigating (fig. 28); and harvesting, drying, and storing methods have been developed and improved through research. Many branches of science have contributed to the development and adaptation of new and improved methods, equipment, and facilities now used in rice culture.

Rotation or Cropping Systems

In most rice-producing areas of the United States, crops are rotated because under continuous cropping the soil usually becomes depleted in fertility and in organic matter. The resulting deterioration of the physical condition of the soil makes seedbed preparation especially difficult. In addition, the soil usually becomes progressively

Figure 28.—A ricefield showing the canal that supplies the irrigation water.

infested with weeds and diseases that lower the yield and quality of the rice.

In the early years in the Carolinas, rice was grown continuously in the same field with only occasional rest (*44*). Later, ricefields in that area sometimes were planted to oats in the fall, followed by potatoes the next year. Some farmers grew rice and cotton in alternate years. This helped to control weeds in both crops.

In the early years in the South Central States, fields were cropped to rice year after year until the rice yields became low and the quality poor because of the mixtures of weed seed and red rice in the threshed grain. Fields then were allowed to lie idle for 1 or 2 years, and then were again put back into rice. This helped to increase rice yields but did not control the weeds satisfactorily. Therefore, ricefields were grazed during the years that they were "laid-out." This practice helped to control grass and weeds but did not control red rice. Some farmers practiced summer-fallowing for a year or two between rice crops and in this way controlled weeds and red rice more effectively than when the fields were idle.

Modern riceland cropping systems are based on information gained from controlled experiments and from grower experience. The preferred system for any farm depends on soil type,

[1] Italic numbers in parentheses refer to Selected References, p. 106.

local climatic conditions, and economic considerations.

Arkansas

Rotation experiments were begun in 1927 at the Rice Branch Experiment Station, Stuttgart, Ark. Because of the numerous factors known to affect rice yields, many rotations were tried, along with several combinations of delayed seeding, tillage for weed control, and summer-fallowing. Results included the following (*93*, *94*):

(1) In 2-, 3-, and 4-year rotations, best yields were obtained when rice was grown not more than half the time.

(2) Rice rotated with fallow or early planted soybeans (for beans or hay) or lespedeza (for hay) produced 1,000 pounds more rice per acre in the year it was grown than when rice was grown continuously. Over a 7-year period of continuous cropping, rice yields declined 180 pounds per acre.

(3) The best 3-year rotation was 1 year of soybeans, followed by a winter vetch cover crop, and 2 years of rice. Rice yield increase was greatest the first year.

(4) As compared to continuous rice, 4-year rotations of soybeans-oats-rice gave large yield increases in the first year of rice, but only half as large an increase in the second year of rice.

(5) Rice yields were significantly increased by plowing down legume green manure crops, including soybeans, lespedeza, and hairy vetch (*Vicia villosa* Roth) immediately preceding the rice crops. All green manure treatments increased rice yield more than did chemical fertilizer applied to the preceding crop in the rotation.

Simmons (*115*) reviewed Arkansas rice rotation research, discussing 3-, 5-, 6-, and 8-year systems. These systems involved rice on the land for half of the time or less and soybeans, oats, lespedeza, or hairy vetch the rest of the time.

Perkins and Lund (*100*) listed ways in which good rotations would benefit the farmer, but cautioned that these rotations would not replace mineral plant food elements such as phosphorus and potassium. They stated that legumes may supply considerable nitrogen, but more nitrogen may be needed. They also stated that rotations will aid in disease and insect control, but other control measures may be required.

In 1947 the order of frequency of crops in the Arkansas rice area was rice, oats, lespedeza, soybeans, corn, and cotton (*120*). The most prevalent cropping systems on small rice farms in Arkansas were 4 or 6 years long, with rice being grown on the land for 2 or 3 consecutive years (*90*, *91*). These systems included growing rice and leaving the land idle, a rotation of rice, oats, and lespedeza, and a rotation of rice and soybeans. Returns to the operators were slightly higher with only one-third of the land in rice than with one-half of the land in rice, if other crops such as oats, lespedeza, and soybeans were grown and harvested to supplement income.

Forty percent of the operators of large rice farms followed a cropping system including rice and oats, with the oats in many cases being overseeded with lespedeza; and almost all operators had some fallow and idle land. Approximately 25 percent of the farmers produced soybeans, and about 35 percent produced beef cattle. The second most common rotation was rice-oats-lespedeza-soybeans, with 42 percent of the land being used for rice under this cropping system.

In 1962, the crops most often grown in rotation with rice in Arkansas were soybeans and oats. Legume green manure crops were used infrequently. In recent years, 1 or 2 years of lespedeza in a rice rotation has sometimes led to considerable damage to rice from the so-called lespedeza worm, grape colaspis, *Maecolaspis flavida* (Say). However, chemical controls for this insect have been developed by Rolston and Rouse (*107*).

The rotation of rice with reservoirs used for fish production and as a source of irrigation water has been practiced in Arkansas (*46*). In some instances, the rotation has produced substantial increases in rice yields, even without the use of commercial fertilizer on the rice crops. The rotation may include 2 years of fish and 2 years of rice or 1 year of fish and 1 or 2 years of rice. Leaving a reservoir in fish for longer than 2 years is usually unsatisfactory because the accumulated fertility results in excessive vegetative growth of the rice the first year after fish. In some cases, even 2 years in fish results in excessive vegetative growth and severe lodging of the following rice crop.

Experiments by Sims (*117*, *118*) indicate that a large part of the increased vegetative growth of rice may be attributed to the accumulation of ammonium nitrogen in the soil during the period the reservoirs were in water and fish. Excessive vegetative growth of rice may be avoided by growing a row crop such as soybeans, grain sorghum, or corn in the rotation the first year following fish or water and then growing rice the second year. In one field test on a clay soil that had been in fish 2 years, all of these crops reduced the ammonium nitrogen content of the soil from 175 pounds per acre at seeding time to 40 pounds per acre at harvest. Rice grown on the experimental area the second year did not lodge.

In ricefields where high soil fertility resulted in excessive early vegetative growth, draining the fields and allowing them to dry thoroughly before the development of the rice panicles (heads) at the early jointing stage of growth

helped retard later vegetative growth of the rice and helped reduce lodging.

Green (*45*) reviewed the problems of fish farming and stated that haphazard raising of fish must be supplanted by more scientific production and marketing practices.

Green and White (*47*) recently have compared three selected 4-year rice rotations in eastern Arkansas. These rotations were fish-fish-rice-rice, soybeans-soybeans-rice-rice, and idle-fallow-rice-rice. Combinations of buffalo and bass were the fish species most commonly stocked. These studies indicated that a total of 881 pounds of buffalo and 181 pounds of bass per acre must be produced and marketed during the 2-year fish period for this system of land management to be as profitable as the soybean-rice rotation. This level of production is considerably higher than that reported by the 35 fish-rice farmers whose operations were included in the study.

Preliminary experiments conducted at the Rice Experiment Station at Crowley, La., showed that good-quality catfish could be produced under conditions similar to those in flooded ricefields without major disease or parasite problems (*128*). To help answer some of the complex problems encountered in the growing of fish and in the use of fish-rice rotations, a Fish Farming Experimental Station was established in 1961 at Stuttgart, Ark., by the Fish and Wildlife Service of the U.S. Department of the Interior. In cooperation with the University of Arkansas, experiments have been initiated to determine suitable management and fertilization practices (*116*).

Sullivan (*136*) reported that some Arkansas farmers in recent years have started to rotate water and crops. Their fields are kept flooded 1 or 2 years and then seeded to rice. According to Sullivan, benefits under this system include increased organic matter content of the soil, improved physical soil characteristics, improved weed control, and improved recreational and wildlife facilities.

Louisiana

Reporting on early experiments in rice production in southwestern Louisiana, Chambliss and Jenkins (*19*) in 1925 stated: "Good drainage, good tillage, and proper rotation make unnecessary the application of any commercial fertilizer to the Crowley silt loam at the present time." Results obtained at the Crowley Rice Experiment Station from 1913 to 1923, inclusive, showed that rice in rotation with soybeans averaged 2,384 pounds per acre, as compared with 1,243 pounds per acre for continuous rice. Efficient drainage and good tillage, supplemented by the organic matter added to the soil by plowing under mature soybean plant remnants after harvest, gave greater returns than were obtained from commercial fertilizer applied to the rice crop. In addition, the soil was left in a loose, friable condition, which facilitated the preparation of a better rice seedbed.

Jenkins and Jones (*62*) in 1944 pointed out that the rice crop, like other cereals, responds to appropriate cultural methods and rotation systems. At the time their experiments were started in 1934, the rice crop normally was grown in alternate years or once in 3 years on land fallowed or left in stubble pasture for 1 or 2 years. In 2-year rotations, the highest yields of rice were obtained following Italian ryegrass, clovers, or stubble pasture. Another experiment demonstrated how other crops grown in the rotation may influence rice yield. The average yield of rice following cotton that had been dusted with calcium arsenate was 30 percent below the yield following cotton that had not been dusted. The reduced yield apparently was due to the adverse residual effect of the calcium arsenate upon the ensuing rice crop. Reed and Sturgis (*104*) in 1936 showed that arsenic toxicity symptoms in the rice plants are similar to those of straighthead in which case florets may be distorted and seed set may be reduced markedly.

The average yields of cotton and soybeans in a 3-year rotation of cotton, soybeans, and rice were too low to be profitable, and the average yields of rice was slightly less from this rotation than from the better 2-year rotations.

In 4-year rotations consisting of rice 2 years followed either by 2 years of cotton (fertilized and not fertilized) or by 2 years of native pasture (fertilized and not fertilized), the yields of rice were not increased by fertilizing; but the rice following native pasture yielded somewhat more than did the rice following cotton.

In 10-year rotations of 5 successive rice crops following 5 years each in (1) improved pasture, (2) native pasture, (3) corn plus soybeans, or (4) cotton, the 4-year average yield per acre of rice was 2,192 pounds following improved pasture; 2,120 pounds following native pasture; 2,052 pounds following corn plus soybeans; and 1,444 pounds following cotton dusted with calcium arsenate.

On land cropped continuously to rice for 49 years, the average annual yields for successive 5-year periods during the last 30 of the 49 years ranged from 1,102 to 1,440 pounds per acre. Fluctuations in the 5-year average yields apparently were due to variations in climatic conditions and were not the result of depletion of the soil fertility, according to Jenkins and Jones (*62*).

Walker and Sturgis (*141*) reported in 1946 that pasture-rice rotation experiments begun in 1938 and conducted on three soil types of the

prairie rice area of Louisiana showed that a 12-month grazing program could be developed. They stated that up to that time the rotation of improved pasture with rice definitely was the best means found of increasing rice yields and of improving the soil productivity of the area. Also, where proper management practices were used, yields of beef from improved pastures exceeded yields from unimproved pastures by more than 150 pounds per acre. In addition, turning under improved-pasture sod ahead of rice crops increased rice yields 1,000 to 1,800 pounds per acre.

Black and Walker (*16*) reported in 1955 on a 5-year rotation experiment that was established at five locations in Louisiana, from 1946 to 1953, on four soil types. The results of these five experiments substantiated earlier work on pasture-rice rotation in southwest Louisiana. They found that if improved pastures are established, it is desirable to provide contour levees and irrigation during dry periods, so that full benefits can be received from the relatively large investment required to establish improved pastures. Also, it was necessary to obtain a minimum of 3 years' grazing from an improved pasture before planting it to rice, since an improved pasture produces only about two-thirds as much in the first year as in the second and third years, and the initial cost of an improved pasture is fairly high. Black and Walker concluded that in southwest Louisiana a long-time rotation of improved pasture and rice is superior to the more common rotation of 1 year of rice followed by 1 year of native pasture.

Davis, Sonnier, and White (*24*) in 1963 described an experiment initiated in 1953 to determine the optimum length of time for pasture-rice rotations in southwest Louisiana. Rotations included 1 year native or improved pasture and 1 year rice; 2 years improved pasture and 1 year rice; 3 years improved pasture and 2 years rice; and 4 years improved pasture and 2 years rice. Fertilization practices varied according to needs shown by soil tests and good agronomic practices. In this study, length of rotation and pasture treatment had little effect on yield of rice. This is believed to be the result of using more fertilizer and the fact that existing soil conditions were somewhat better in this experiment than in earlier experiments in the area. Improved pastures in the rotation increased the yield of beef more than 500 percent.

In reporting on an economic appraisal of farm practices and rotation programs on Louisiana rice farms, Mullins (*88*) in 1954 pointed out that the most common rotation at that time was 1 year of rice and 1 or 2 years of native pasture. Some longer rotations were being used such as rice 2 years and improved pasture 3 or 4 years. In the longer rotations a smaller proportion of the cropland was in rice each year, but the increase in rice yields was sufficient to maintain about the same total volume of rice production on the farm.

A rotation of rice for 2 years and temporary pasture for 3 years gave an average rice yield of 2,600 pounds per acre, as compared with 1,950 pounds per acre from rice alternated with native pasture in a 2-year rotation. When rice was grown for 2 years following 3 years of temporary pasture, the estimated average rice yield for the 2 years was about 3,250 pounds per acre. Leaving land in pasture for a fourth year added an additional 150 pounds per acre to this average rice yield. In addition, the quality of rice improved and this, combined with higher production of beef feeding on the temporary pasture, gave substantially higher net return to rice farmers.

Mississippi

Thompson and Waller (*137*) in 1952 suggested using rotations of rice-soybeans-soybeans or rice-lespedeza(for hay or grazing)-soybeans in Mississippi. As recently as 1962, Anderson and McKie (*11*) cautioned growers about substantially decreased yields from growing continuous rice and suggested that a field be held out of rice for 2 to 4 years, during which time the weed population should be reduced. Rice was commonly grown 2 years and was followed by fallow or soybeans. Some growers also used wheat and oats in the rotation.

Mullins (*89*) in 1960 pointed out that in Mississippi rice is grown in the delta area on clay soils. When a relatively short rotation period of 2 to 3 years is used, farmers generally summer-fallow about as much land as they seed to rice. The fallowed land requires little preparation for seeding the next spring. Rice is not grown on the same field for the second year in such rotations, and rotational crops such as soybeans or small grains usually are omitted.

Some growers use a 5- or 6-year rotation, with rice 2 years and then no rice for 3 or 4 years. When delta rice farmers use longer crop rotation systems, at least half of the rice each year is seeded on land that grew either rice or other crops the previous year. Where rice followed rice, a few operators burned the stubble to facilitate land preparation for the second year of rice. In these longer rotations, the major crop grown in rotation with rice was soybeans. The next most commonly grown crop was wheat. On a small number of farms, oats were grown.

Where adequate surface drainage was available, wheat and oats were well adapted to the clay soils of the rice farms in Mississippi. These small grain crops fit reasonablly well into the rice rotation programs. They usually were seeded on

land that had lain idle and had been fallowed the previous summer or on land from which early-maturing soybeans had been harvested. Small grains following soybeans did not always produce satisfactory yields because there was only a short time to prepare a suitable seedbed. This sometimes delayed seeding of small grains and the delay often led to damage from winterkilling. Where the harvesting of small grain was not delayed, it was possible to double crop the land with late-planted soybeans. Because of the risk, some growers preferred to summer-fallow the land before seeding rice or soybeans the following spring.

Missouri

Experiments in Missouri reported by King (*74*) in 1937 demonstrated that crop rotation was essential to continued high rice yields on Wabash clay (gumbo) soils. In a 6-year period, yields on continuous rice plots dropped to 450 pounds per acre because of infestation with weeds. Rice yields were as high from a 2-year rotation of rice and soybeans as from 4-year rotations that included rice and other crops such as soybeans, wheat, clover, and corn.

Texas

In a review of research on rice production in Texas, Reynolds (*105*) stated: "High yields of rice have not been sustained by growing rice on the same land every year. Nor has the growing of cultivated crops in rotation with rice proved practical in most of the Texas rice belt."

It is a common practice to grow rice 1 or 2 years and to follow this with several years of grazing beef cattle on volunteer vegetation. Sometimes the land is merely left idle for 2 years or more. When rice follows unimproved pasture or idle land, the improved physical condition and the increased organic matter content of the soil increase rice yields.

Workers at the Beaumont station started research on rotations and cropping systems in 1913. From 1931 to 1941, a number of rotations were tried. The average yields of rice per acre were as follows: continuous rice, 1,072 pounds; continuous rice with fall-seeded sourclover (*Melilotus indica* (L.) All.), 1,194 pounds; rice 1 year and idle 1 year, 1,613 pounds; rice 1 year, fallow 1 year, 1,635 pounds; rice 1 year, cotton 1 year, 1,707 pounds; rice 1 year, soybeans 1 year, 1,618 pounds; rice 1 year, sesbania 1 year, 1,725 pounds; rice 1 year, crotalaria 1 year, 1,642 pounds.

Studies from 1943 to 1945 indicated that rotations of alyceclover for pasture and rice were more satisfactory than were other rotations. Rice following alyceclover produced 2,500 to 2,860 pounds per acre, as compared with 1,800 pounds where the rice did not follow clover. These results led to investigations started in 1946 on the rapid, low-cost conversion from rice to improved pasture in rice-pasture systems.

As reported by Reynolds (*105*), Moncrief and Weihing found it practical to convert from rice to pasture by broadcasting grass and clover seed, without seedbed preparation, in standing rice at the last draining about 10 days before harvest and in rice stubble after harvest. The levees and drainage ditches used to irrigate and drain the rice were used to irrigate and drain the improved pastures. In the more humid areas a mixture of dallisgrass and clover (Louisiana white, Persian, and large hop) was successful. In drier areas Hubam sweetclover was a more satisfactory legume. It was found that bermudagrass usually volunteered. Ryegrass, tall fescue, and cereals were seeded successfully at the last draining of the ricefields and in the rice stubble. Lespedeza could be established by broadcasting the seed in rice stubble in late February or early March.

Rice yields following improved pastures were increased by 20 percent or more. In addition, as much as 200 pounds of annual beef gains per acre were obtained on the improved pastures, as compared with less than 50 pounds on unseeded, unfertilized pasture fields. The clovers and bermudagrass, and sometimes dallisgrass, volunteered after the rice crop to provide grasses and legumes for the next pasture period. In some cases, pasture seed and hay could be harvested from these fields.

In summary, Reynolds (*105*) stated: "The several possible rice-pasture systems of farming have not been fully evaluated. However, such systems as 2 years rice, 3 years pasture; 2 or 3 years rice, several years pasture; 1 year rice, 2 to 3 years pasture seem to be worth considering in systems to maintain and improve soil tilth and productivity between rice crops, as well as for providing year-long grazing of nutritious forage for beef cattle on rice farms."

In a report on their studies of year-long grazing in the rice-pasture system of farming, Weihing, Moncrief, and Davis (*146*) reported that the unimproved pastures were grazed only 201 days during the year, whereas the improved pastures were grazed the full 365 days. In addition, the carrying capacity of the improved pastures was about three times that of the unimproved pastures from April 14 to November 7, 1949; and gains on the improved pastures were nearly four times those on unimproved pastures. Management practices, including fertilization and inoculation of clover seed, were important in establishing improved pastures.

Evatt and Weihing (*33*) reported that rice following improved pastures produced 650 to 800 pounds more per acre than did rice following unimproved pastures when equal amounts of fertilizer were used. The rotations included in this study were (1) rice and unimproved pasture in alternate years; (2) improved pasture 3 years, rice, unimproved pasture, rice; (3) improved pasture 4 years, rice 2 years; and (4) improved pasture 5 years, rice 3 years.

Ratooning is the harvesting of a second grain crop from regrowth of the first rice stubble. The practice is only possible when well-adapted short-season varieties are grown and the area enjoys about 280 frost-free days (*41*). About 35 percent of Texas rice acreage was ratooned in 1963.[2]

Evatt and Beachell (*32*) discussed ratoon cropping of short-season rice varieties in Texas. They reported that the technique appears to be a practical means of increasing rice yields, provided varieties that mature the first crop in 100 to 105 days are used. It requires about 70 to 80 days to produce the second crop if all operations are properly executed.

Although ratooning now appears to be a practical and possibly profitable operation in United States areas having a suitable climate, expert management is required. Evatt and Beachell (*32*) have shown that the stubble of the first crop should be at least 16 to 18 inches high. Leaving a shorter stubble delays recovery. Significant yield increases have been obtained from the ratoon crop by applying up to 120 pounds of nitrogen per acre immediately after the first harvest. The stubble is reflooded when regrowth is 18 to 20 inches high. Using the early variety Nato, these authors reported 4,048 pounds per acre from the first crop and 2,382 pounds per acre from the ratoon harvest, for a total of 6,430 pounds per acre from a single seeding.

California

No clear-cut rotation pattern has yet become established for California riceland (*68*) for the following reasons:

(1) The soil used for rice production generally is inherently quite fertile. Hence, with the relatively short cropping history as compared with other rice States, soil nutrient depletion, with the exception of nitrogen, has not yet proved a limiting factor.

(2) No serious rice disease has appeared to date to force a rigid crop rotation program for disease control purposes.

(3) The rapidly advancing knowledge of weed control, crop fertilization, and other improved cultural practices has made it possible to crop ricelands for a period of 3 to 10 years continuously and still obtain increasing yields. In 1920, California's average rice yield was 2,295 pounds per acre; in 1963, it was 4,505 pounds per acre.

A number of cash crops are well adapted for growing in rotation with rice in California. The ones most commonly grown are those providing the best immediate economic advantage. One rotation involves rice; spring- or early summer-plowed fallow; and fall-sown wheat, oats, or oats and vetch. Another includes rice; spring-sown grain sorghum or field beans; and fall-sown wheat, oats, or oats and vetch. Safflower may be grown in rotation with rice but production usually is more successful when this crop is grown the second, rather than the first, year after rice.

Two rotational cash crops are sometimes harvested the same year. Wheat or oats may be followed by irrigated grain sorghum, field beans, or safflower. For successful double cropping on riceland, all operations must be expertly timed.

Other crops used occasionally on the better quality, medium-textured riceland soils include sugarbeets, melons for seed, tomatoes, and alfalfa.

Williams, Finfrock, and Miller (*149*) reported that purple vetch (*Vicia atropurpurea* Desf.), burclover (*Medicago hispida* Gaertn.), horsebeans (*Vicia faba* L.), and field peas (*Pisum arvense* L.) were commonly used in ricelands for winter-grown cover crop and green manure. They reported that leguminous green manures were grown and turned under on about one-fifth of California's riceland and that the practice is expanding rapidly.

Land Leveling and Seedbed Preparation

Jones and others (*69*) reported that most land on which rice is grown is comparatively level, with a gentle slope toward the drainage channels. The cost of developing for irrigation lands with from 0.01- to 0.50-percent slope usually is economical. A competent surveyor is employed to locate the irrigation canal, drainage ditches, and field levees. Improper location of canals, ditches, and levees may cause serious losses, since it may result in faulty irrigation and poor drainage. Irrigation canals should be large enough to supply ample water promptly when needed. Drainage ditches should likewise be large enough to dispose of water rapidly.

Land Grading and Leveling

A general discussion of land leveling for irrigation has been published by Bamesberger (*14*). Technical reports of land grading (land forming) for surface irrigation by Gattis, Koch, and McVey (*40*) and Marr (*82*) discuss the factors to consider before land grading is undertaken. These

[2] Evatt, N. S. Texas A & M University, Beaumont, Tex. 1964. [Correspondence.]

include the determination of crops to be grown, the suitability of the land for surface irrigation, the location and amount of water available, the capabilities of various types of land-grading equipment, methods of calculating for land grading, and methods of computation of cut and fill.

In developing land for rice, it usually is customary to move enough earth to eliminate hummocks or ridges and to fill sloughs and hollows. Properly leveled land drains more quickly in the spring, so that seed bed preparation can be started earlier. Land leveling also makes it possible to maintain a uniform depth of 4 to 8 inches of water within levees, to control weeds better, and to drain the water rapidly if necessary during the growing season and for harvest. When a field is properly graded, irrigation levees can be made straight and perpendicular to the slope of the land. This practice reduces the amount of land devoted to levees, decreases tillage and harvest costs, and usually increases yield. After a field has been adequately graded, it can be maintained by annual land planing or floating before seeding the rice.

Wasson and Walker (*145*) pointed out that many types of land-moving machines are available and that the majority of these give good results. Mullins (*89*) found that Mississippi farmers were using land planes or similar land-leveling devices to improve the surface condition of their fields but that this operation usually was performed on only a part of their land each year. Reynolds (*105*) reported that land leveling with land planes or other land-leveling devices is coming into greater use in Texas. He emphasized that leveling increases the uniformity of contours between levees and results in better drainage and water depth control. These conditions are essential to obtain and maintain uniform stands of rice.

Land planing or floating of riceland usually is done after heavy disking, field cultivating, or other means of working the ground. It may be alternated with other operations until the land is suitably level. Often land planing is the last operation before preparing the final seedbed and seeding. The field then should be in suitable condition for accurate surveying of the levees (fig. 29).

In 1962, Faulkner and Miears (*35*) described

FIGURE 29.—Leveling ricefield with (*A*) large land plane and (*B*) small land plane.

methods for leveling riceland in water. They found that ridges and depressions can be leveled more easily and more effectively by flooding the land and working the machinery in the water. Because of the plowsole found in most rice soils, equipment can be supported under flooded conditions. Through using the water as a supplemental moving agent, greater amounts of soil can be moved more efficiently than when the field is dry leveled with the same equipment (fig. 30).

Faulkner and Miears described two methods commonly used in water leveling riceland. One is to build a levee around small land areas and eliminate all other levees within the field. The other, normally used in large fields, is to remove every second levee and level within the remaining areas. With either method, the soil is worked into a loose seedbed and, after being flooded, is

FIGURE 30.—Leveling ricefield in water with small land plane.

moved with a blade and a tractor of 50 horsepower or greater. The blade can be a one-blade land leveler with float removed or it can be any other blade approximately 10 feet wide pulled at a right angle to the direction of travel. Faulkner and Miears recommended flooding only the land that can be leveled in 1 day, since soil becomes compacted when partly worked and then allowed to remain under water overnight. They suggested leveling the land to within 0.2 foot between levees for good water control. This allows a minimum water depth of 4 inches and a maximum depth of 6.4 inches. They found that water depths of less than 4 inches were ineffective in controlling grasses, whereas depths of more than 6.4 inches in Louisiana may injure the rice and result in greater pumping cost for the increased volume of water. Leveling in water normally was difficult where the terrain varied more than 0.6 foot. No extreme changes in soil characteristics were observed after leveling in water. Analyses showed that the soil generally was more uniform in both physical and chemical characteristics after leveling in the water. One advantage was that this uniformity of soil allowed a better determination of needed plant nutrients based on analyses of soil samples.

Seedbed Preparation

Jones and others (*69*) reported that when plowed under, rice stubble and weed growth decompose readily in the fall and winter if proper drainage is provided. This decomposition aids in the preparation of a good seedbed. In recent years in Arkansas, growers have found it satisfactory to disk rice stubble immediately after harvest to mix the vegetative matter with the soil. Sometimes a roller-packer rather than a disk harrow is used to break down the stubble so it is in contact with the soil, then the levees may be closed and allowed to catch winter rainwater that is left on the land until late winter or early spring. At this time the fields are drained; and as soon as they are dry enough, the land is either plowed with a moldboard or disk plow or worked with a heavy disk harrow, depending on the condition of the stubble and the soil.

Mullins (*89*) reported that land preparation operations on the heavy soils of the delta in Mississippi are performed with offset disks, heavy tandem disks, and various types of harrows. The usual sequence is one or two times over with the offset disk, then three or more times over with the tandem disk at varying time intervals. Spike-tooth or spring-tooth harrows are commonly used after each cutting with the disk or for the final operation before seeding.

The seedbed for rice is prepared much the same as the seedbed for other small grains. The procedures generally followed are given by Davis (*26*), Finfrock and Miller (*36*), Jones, Davis, and Williams (*68*), Jones and others (*69*), and Reynolds (*105*). The primary aim is to destroy weeds and to provide a suitable seedbed. Whether it should be rough or mellow on the surface will be governed by the seeding method used. If the rice is to be sown in the water, the soil surface before flooding should be dry and rough; if it is to be drilled, the soil surface should be mellow and smooth.

Depending on the crop that precedes rice in the rotation, it may be desirable to plow the land in the fall or early spring. If rice is to follow soybeans or similar cultivated crops, only a limited amount of land preparation may be necessary since the soil may be in fairly good physical condition after the cultivated crop has been harvested. Reynolds (*105*) reported that early experiments on time and depth of plowing at the Beaumont, Tex., station indicated that soil plowed 5 to 8 inches deep in the fall or spring produced somewhat larger yields of rice than did soil plowed only 2 inches deep. There was little difference in yield of rice between summer, fall, and spring plowing. However, summer, fall, or early winter plowing did have the advantage over spring plowing in that labor was distributed over longer periods. Land that was plowed in the fall formed a better tilth and was easier to prepare for seeding by disking and harrowing the following spring than was land plowed in the spring. Depending on the condition of the soil, riceland generally is plowed with heavy disk or moldboard plows (fig. 31).

Disk plows generally are used when the soil is dry and hard. When the soil is moist and in good condition for plowing, moldboard plows are very satisfactory. In Arkansas, the use of moldboard plows has decreased in favor of various types of disk plows, which can cover the ground more rapidly and which may leave a smoother surface that will require less leveling or floating.

Reynolds (*105*) reported that summer plowing frequently is practical in Texas on fields infested with red rice or other weeds. After summer plowing, the land may be leveled and disked or harrowed as needed for weed control. Land plowed in the fall usually is left rough until spring, then it is disked and harrowed preparatory to seeding. It is desirable to open drainage furrows through a field after the last tillage operation in the fall to provide adequate surface drainage. Some farmers wait until the first heavy rain of the fall when some water is standing on the land to make the drainage furrows so that natural drainage channels can be located. A small grader, a bedder, or a one-bottom plow may be used to make this drainage furrow. Usu-

FIGURE 31.—Preparing the seedbed: *A*, Moldboard plow; *B*, field cultivator with spike-tooth harrow attached; *C*, disk harrow.

ally it is not necessary to plow in the spring the fields that were plowed the previous summer or fall, except on poorly drained soil or during seasons of heavy rainfall.

In general, land plowed in the spring should be disked and harrowed as soon as possible after plowing to break up any large lumps and clods, to prevent baking or crusting, and to avoid subsequent difficulty in preparing the seedbed. In Texas, experience has shown that heavy soils, such as Beaumont clay and Lake Charles clay, generally require more subsequent tillage, such as disking and harrowing, to obtain a desirable seedbed when plowed in the spring than when plowed in the fall or early winter (*105*).

Usually California ricelands are spring plowed to a depth of 4 to 6 inches, after the stubble of the previous crop has been partly reduced by burning. The straw may be burned in the fall immediately after rice harvest if dry weather continues long enough. Spring-plowed soils make a better seedbed if allowed to dry for a week to 10 days after plowing before beginning the final seedbed operations. Davis (*26*) reported that water-seeded rice germinates better, has more seedling vigor, and produces a heavier crop when sown on a seedbed that is dry during the finishing operations. A seedbed prepared under moist conditions for water seeding induces algae (scum) development, increases weed problems, and frequently results in a poor stand because of poor germination and seedling vigor.

Finfrock and Miller (*36*) reported that a good winter-grown vetch cover crop aids in drying out riceland soil, thereby making it possible to prepare the seedbed earlier. Cover crops turned under for green manure are usually plowed down with a moldboard or a disk plow. For best results in California, the plant material should be completely covered with 4 to 6 inches of soil, according to Williams and others (*148*, *149*).

Seedbed Preparation as Related to Method of Seeding

Rice may be seeded either by drilling on dry ground, or by broadcast seeding with an endgate seeder or airplane on dry ground or in flooded fields. The final seedbed preparation is influenced by the method of seeding to be used. If fields are to be water seeded, growers sometimes are able to prepare a fairly good seedbed in the late fall or winter and to erect their levees at this time. When this is possible, very little land preparation other than harrowing is necessary in the spring. In the Southern States, if the field is to be dry seeded with a drill or with an endgate seeder or broadcast by airplane, the final preparation of the field includes working over the levees while the field is worked. When rice is to be seeded, the final preparation just ahead of the drill usually is done with a spring-tooth or disk harrow behind which is drawn a spike-tooth harrow. This gives a mellow firm seedbed, and the moisture is held near the surface so the seed usually will germinate soon after seeding without irrigating the field. A roller-packer may be used in order to break up clods before drilling and to firm the soil after drilling to help retain moisture. Usually, the levees are reseeded after

they have been partly rebuilt, and the seed then is covered by the final building of the levees with a levee disk or a pusher-type levee maker.

If rice is to be broadcast seeded on dry ground, the final seedbed preparation leaves the surface rough and somewhat cloddy. The seed usually is covered by a shallow working with a spring-tooth, spike-tooth, or disk harrow. Seed on the levees is covered by the final working with the levee disk or pusher. In most cases, precipitation following seeding is necessary to bring about germination and emergence of the rice seedlings.

If a field is to be water seeded, the final seedbed preparation depends somewhat on soil type. On sandy or silt loam soil, a mellow, firm seedbed similar to that for drilling should be prepared. Levees are constructed and are seeded just before the final working with a levee disk or pusher. The remainder of the field is worked between the levees with a spring-tooth harrow, which leaves fairly deep furrows into which the seeds fall as they settle through the water.

When rice is water seeded on clay or very fine silt loam soil, the seedbed should be fairly rough with a clod size ranging up to 4 inches in diameter. This is done in California by harrowing twice with a heavy spike-tooth harrow followed by dragging with a heavy wooden drag. A rough seedbed helps prevent drifting of water-sown seed. As the clods slake down after flooding and seeding, a fine film of soil may cover the seed. In the South, the levees usually are seeded separately. In California, the levees are considerably higher and larger and are not seeded.

Some farmers have been successful in preparing their land in relatively stale water by drawing spring-tooth or spike-tooth harrows through the fields in the mud or in fairly deep water. Other growers who have attempted this method have found it very unsatisfactory.

Construction of Levees

Ricefields are divided by levees into subfields, called paddies or bays (cuts). Levee construction is an important operation in preparation for growing rice because levees are the key device for regulating water depth in ricefields. They must be located accurately and must be well constructed in order to maintain a uniform depth of water within each paddy (fig. 32).

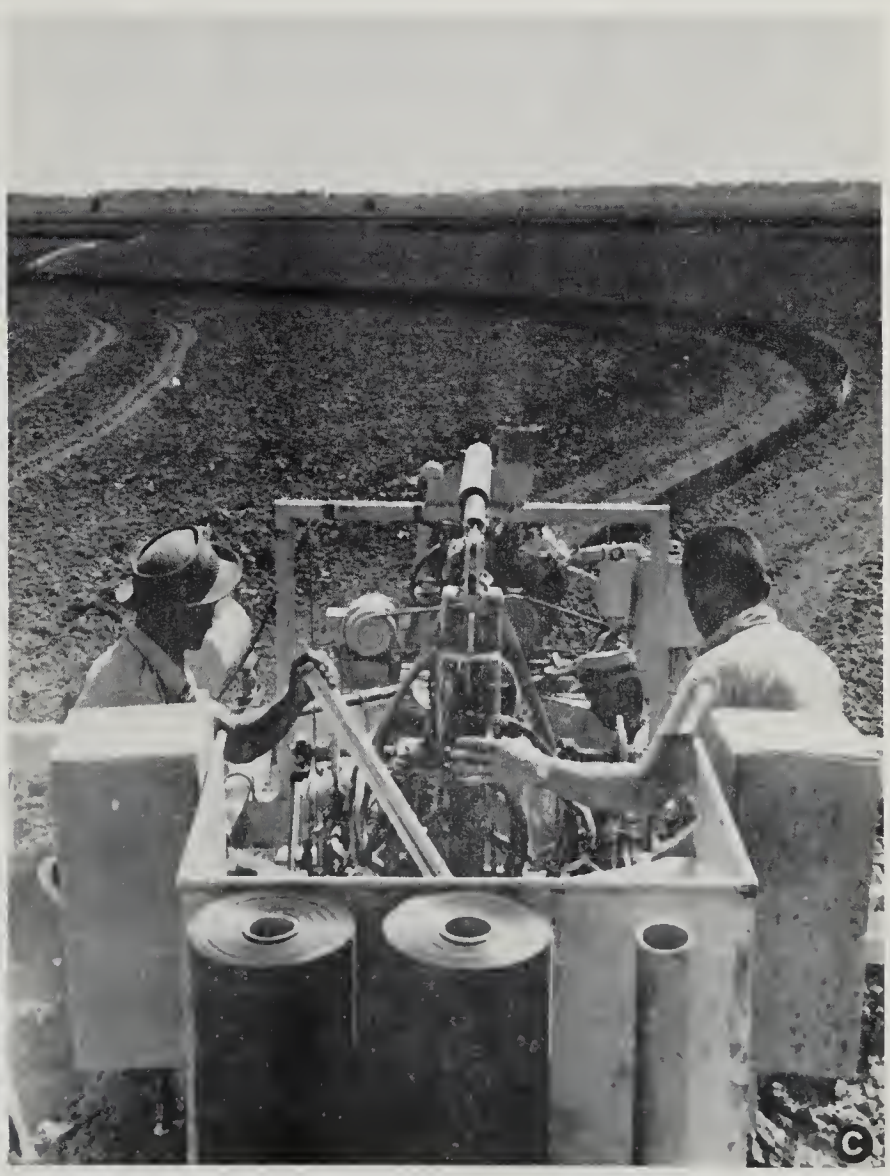

FIGURE 32.—Making levees with (*A*) disk, (*B*) pusher, and (*C*) plastic.

The levees are constructed on the contour, that is, on lines of equal elevation. They should be located by an experienced surveyor or operator who uses an accurate instrument. Because a smooth soil surface is needed for accurate location of the levees, the surveying should be done immediately after the field has been floated. On flat land, the difference in elevation between levees is 0.1 to 0.2 foot, and on steep, sloping land it is 0.3 foot (*37*, *69*). In fields where the levees run parallel to the direction of the prevailing wind, it is desirable, especially if the paddy is large, to build wind levees at right angles to the direction of the prevailing wind. These levees are not tied into the border or contour levees. Their function is to reduce the effect of the wind and thereby decrease wave action and reduce the possibility of levees being washed out.

The levee should be compact and high enough to hold the water at an average depth of 3 to 6 inches in the paddy. In the Southern States, the levees have gently sloping sides, so that they may be crossed with cultivating and harvesting equipment. Here, the levees are completed after the rice is drilled. Levees of this type are considered very efficient, for an entire field can be cultivated, seeded, and harvested as a single unit.

In California, the levees are higher and have steep sides so as to hold a deeper flood; and the areas between pairs of levees must be harvested as a field or unit. This increases farming costs because it increases machinery-maneuvering time. In addition, the land area devoted to high levees is nonproductive.

In the Southern States, the base of the levee commonly is made by plowing one round with a 3-bottom plow. Levees are constructed with a levee disk usually mounted on the rear of a large tractor, or commonly with a single- or double-blade pusher on clay soils. The levee base is built as early as possible, so that it will become compact before flooding time. This is especially important on heavy clay soils on which levee construction often is difficult. Compact, well-settled levees reduce seepage and are less likely to be washed out by excess water from heavy rains. Well-constructed levees, properly repaired after seeding, facilitate irrigation and eliminate much expensive hand shoveling. Much of the work of installing levee gates and closing the gaps at the ends of the levees is done with pickup blades or scoops mounted on small tractors. This eliminates much of the hand labor formerly required.

In California, a V-type diker or soil crowder that is 14 to 16 feet wide in front and 4 feet wide in the back is used to build levees. Two or more heavy-duty, crawler-type tractors are used to pull the diker. The levees usually are from 30 to 36 inches high when freshly made and settle to between 16 to 20 inches. Levees usually are made in the fall with a base of 5 to 6 feet and are allowed to settle during the winter. A bulldozer or a tractor with a front-end scoop is used to close the gap at the water control boxes and at the end of each levee.

Lewis and others (*75*) and Scott and others (*113*) reported on the possibility of using rice levees made of plastic film in lieu of levees made of soil. Their studies show that plastic levees are physically feasible. Their commercial feasibility probably depends on the development of a machine to economically install the plastic levees. Prototype, privately developed machines to install plastic levees mechanically were operated experimentally in California in 1962 and in 1963.

Seed and Seeding

The choice of seed and the use of suitable seeding methods are an important part of rice culture. To achieve a high level of production, the variety to be grown must be adapted for the area. After deciding on the variety, it is necessary to select a lot of rice seed that is free from varietal mixtures, does not contain red rice and weed seed, is high in percentage of viable seed, and has high bushel weight. All rice-producing States now have a rice seed certification program designed to provide high-quality seed for the rice industry.

Before 1941, when combine harvesting, artificial drying, and bulk storage were begun in the southern rice area, there was little incentive to develop a seed rice industry. Varietal mixtures resulting from handling were not serious when binders, stationary threshers, and sack storage were used. Seed rice usually was saved from fields or parts of fields of known varietal purity. Weed seeds and trash were removed by fanning mills and disk or cylinder graders usually owned and operated by private or grower organizations. However, as combine harvesting, artificial drying, and bulk storage developed, varietal mixtures became serious. It was at this time that seed production and processing developed into a specialized business. Today, much of the seed rice sown in the Southern States is given specialized attention during growing, harvesting, drying, and processing. As a result, the seed rice industry is well developed today. Foreign demand for seed of high quality has further stimulated the development of the seed rice industry. Substantial quantities of seed rice are exported annually to Central and South American countries.

Seed Quality

Numerous workers have stressed the desirability of using seed rice of good quality (*18*, *27*, *70*, *124*). Good seed should be well matured and free from red rice, immature and hulled or broken grains,

seed of other varieties, and weed seeds. The seed should be cleaned and graded to remove hulls, trash, and other foreign matter. Also, good seed should germinate satisfactorily and should produce strong sprouts. Using seed that germinates poorly may result in uneven stands, uneven ripening, and low field yields of poor milling quality.

Smith (*124*) reported in 1940 that seed lots used on 29 farms were examined, and only 4 were found to be free of weed seeds and red rice. Today, most rice seed is thoroughly cleaned and graded. Consequently, it is free of weed seed and has only a trace of hulled or poorly filled grains.

Much emphasis has been placed on the importance of eliminating red rice from planting seed (*2, 70*). Red rice is objectionable because the red bran is not completely removed in milling. This results in an unattractive appearance when milled. Also, the grain size, shape, and milling quality are inferior. Red rice tillers profusely and shatters easily, and seeds that have become buried in the soil have been known to remain viable for several years (*19, 43*). When rice seed containing red rice was seeded several years in succession on the same land and red rice was not controlled, over 50 percent of the harvested grain was red rice (*2*). In a ricefield in Louisiana, over 500 red rice grains were found in the top 6 inches of each square foot of soil.[3]

The importance of using seed free from red rice cannot be overemphasized because as long as red rice is being sown, it cannot be eliminated from the fields. Based on a seeding rate of 80 pounds per acre, seed containing 5 red rice grains per pound would probably result in approximately 200 red rice plants per acre. At the Beaumont Rice-Pasture Research and Extension Center, land was cropped 2 consecutive years, in 1946 and 1947, and seed was used that contained approximately two red rice grains per pound. The grain harvested the first year contained about 18 red rice grains per pound and that harvested the second year contained over 125 grains.[4]

Seed rice free from red rice was nearly nonexistent until 10 years ago. Screen graders, which effectively grade seed rice on a grain diameter basis, have been effective in removing the broader red rice grains from long-grain varieties. The screen graders, along with the production and increase of seed stocks free from red rice, have effectively controlled red rice. In a few instances, slender red rice grains that cannot be separated from long-grain varieties have been observed. Whenever a seed lot that contains such types is observed, it should be discarded immediately.

[3] BAKER, J. B. Louisiana State Univ., Baton Rouge, La. 1963. [Correspondence.]

[4] BEACHELL, H. M. Rice-Pasture Research and Extension Center, Beaumont, Tex. 1963. [Unpublished data.]

Red rice grains are difficult to remove from short- and medium-grain varieties because of the similarity in diameter between those varieties and red rice. Since red rice grains cannot be effectively removed from the medium- and short-grain varieties, it is essential to use seed free from red rice.

The origin of high-quality seed rice and the certification of rice seed is discussed in the section on "Rice Breeding and Testing Methods in the United States," p. 56.

Source of Seed

Jones and others (*67*) studied the effect of environment and source of seed on yield and other characters of a group of varieties at four rice experiment stations in Arkansas, Louisiana, Texas, and California. They concluded that seed source had no appreciable effect on grain test weight, germination of seed, average grain and kernel weights within a variety, proportion of hulls, and milling quality. In summary, they stated that "local seed of good quality, free of mixtures and weed seed, is as productive as that obtained from other rice-producing States."

Seed Treatment

Finfrock and Miller (*36*) reported that California growers usually soak their rice seed in a sodium hypochlorite solution at the rate of 1 gallon of household bleach (5.25 percent of NaOCl) per 100 gallons of water. In addition to providing some protection against seedling diseases, the chemical deactivates germination inhibitors located in rice hulls.

Mikkelsen and Sinah (*84*) reported the presence of six compounds in the hulls of Caloro rice that diffuse into the embryo and inhibit germination when present in large amounts. Compounds identified included vanillic acid, ferulic acid, p-hydroxybenzoic acid, p-coumoric acid, p-hydroxybenzaldehyde, and possibly idoleacetic acid. In low concentrations, these chemical substances stimulate germination and ensuing growth. Leaching the seed by soaking with water reduces the concentration to stimulatory levels. The probable action of sodium hypochlorite solution is to modify these inhibitors so that seedling growth is stimulated.

Garrison (*39*) reported on work with other small grains conducted by Earhart. Results showed that there is a definite need for all small grain seed to be completely processed, including thorough cleaning and treating. For every 100 field-run seeds put in the ground, only 58 healthy plants were produced. When seed from the same lot was cleaned, 65 healthy plants were produced; and when the seed was both cleaned and treated, 72 healthy plants were produced. Field experiments comprising two rice varieties, sown at two

dates at each of three locations for 2 years, showed an average survival of 61 percent for seed treated with two commonly used seed-treatment chemicals, compared with 52 percent for untreated seed (*12*).

Information on the treatment of rice seed to prevent seedling blight is given in the section "Rice Diseases," p. 113.

Time of Seeding

Seeding of rice in the United States begins when the weather becomes warm enough for germination and seedling growth. In Arkansas, Mississippi, Missouri, and California, where the growing season is comparatively short, seeding usually is done in April and May, within a period of 3 to 5 weeks. Near the Gulf Coast in Louisiana and Texas, rice can be sown from early March to late June—although most seeding is done in April.

The length of seeding period depends mostly on the length of life cycle of the available varieties. Essentially it is the difference between the length of the growing season for rice in an area and the shortest period of time required to mature a crop.

Seeding time also is influenced, directly or indirectly, by favorable weather conditions for land preparation and seeding operations, methods of seeding, fertilizer practices, availability of fresh water, temperature of water, cold tolerance of varieties, and time of maturity of varieties in relation to date of seeding.

Adair and Cralley (*5*) stressed that the proper seeding date for each variety is important. They stated that no rice variety should be sown until the mean daily temperature rises to about 70° F. They and Johnston and others (*65*, *66*) reported that because of the relatively long growing period of several of the varieties then available, it was necessary to seed these varieties in Arkansas by late April or early May. Other, shorter season varieties had a wider range of seeding dates. However, when any variety then available was sown in Arkansas after the first week in June, there was a risk that the crop might fail to mature if there was an early frost. However, with the development of the very early-maturing varieties Belle Patna and Vegold, mid-June seedings appear to be relatively safe, even in northern Arkansas. Johnston and others (*64*) suggested that these two varieties be seeded in northern Arkansas from about June 1 to 10, in central Arkansas from about June 1 to 20, and in southern Arkansas from June 1 to 25. Johnston, Cralley, and Henry (*66*) emphasized that a relatively "safe" seeding date may depend to a considerable extent on anticipated water management and fertilizer practices. They pointed out that heavy rates of nitrogen fertilization, particularly when applied late, tend to delay maturity.

Results from date of seeding experiments indicate that there is a comparatively long period in the South during which rice can be sown and still produce satisfactory yields. It is possible and often advisable to spread the seeding time of certain varieties so that the harvest can be extended over a longer period. However, Adair (*4*), who studied the effect of time of seeding on yield and milling quality in Arkansas, concluded that most of the early and midseason varieties produced rice of better milling quality when they matured late in September or early in October than when they matured before September 15. Jodon (*63*) stated that since the approximate number of days required from seeding to maturity is known for all commercial varieties, it may be desirable to base the date of seeding on the number of days required for maturity, so that the rice will mature in the fall when the weather is usually dry and pleasant for harvest. Rice maturing after the temperatures have lowered somewhat may be of better milling quality. When rice matures during extremely hot weather, considerable sun checking may result and low head rice yields may be produced when the grain is milled.

Chambliss (*18*) stated that in the prairie areas of Louisiana and Texas, most of the rice is sown from April 1 to May 15. However, he pointed out that May 1 was approximately the best date for sowing rice on the prairie because of the cold weather that sometimes prevails during April. According to Jones and others (*69*), rice usually is sown in the Southern States from April 1 to May 30. But if conditions are favorable, some seeding is done in March and as late as June 30. Rice germinates more quickly when sown in the late spring, when temperatures are relatively high, than when sown earlier. Also, late seeding has an advantage in that the weeds that have started growth can be killed by cultivation before seeding of the rice crop.

Reynolds (*105*) stated that time of seeding rice in Texas ranges from March 1 to late June but that most of the rice acreage is seeded in April and May. He pointed out that the actual time of seeding may depend on several factors, such as the weather, method of seeding, soil condition, and maturity group of the variety. Some varieties can tolerate cool weather in the spring better than others and will thereby produce better stands when seeded relatively early. He further reported that the yield of certain varieties showed a marked decrease when seeding was delayed beyond certain dates. He concluded from tests at Beaumont that the late-maturing varieties should be seeded as early as practicable to insure satisfactory yields.

In California, the period for seeding rice is more concentrated than it is in the South. Some rice is sown in California soon after April 1 and some as late as June 15, but most of it is sown from April 15 to May 15 (*36*). When rice is sown as late as May 30 in California, it should be fertilized at a moderate rate, and preferably a short-season variety such as Colusa should be grown.

Very early seeding entails certain hazards such as loss of stands due to seedling blight or drowning out of drilled rice. Early growth is slow, prolonging the period from seeding to harvesting. Isolated early-maturing fields may be attacked by concentrations of insects, rodents, or birds. Rice that matures early during hot and dry weather tends to have lower milling quality.

Relatively early seeding in the Southern States helps assure an adequate supply of water to mature the crop before a summertime shortage of water or, in limited areas where it occurs, before the intrusion of salt water. Water is available for early-seeded rice in all areas, although in California the water may be too cold. Early-seeded rice may tiller more, may compete more effectively with weeds, and may escape insects and diseases to some extent. When rice can be harvested early in the season, it usually is possible to avoid seasonal congestion at the driers and to find a ready market. Also, early seeding of short-season varieties usually allows time for the production of a stubble crop in southern Louisiana and Texas. Because of the somewhat shorter growing season and cooler fall temperatures, results and observations indicate that such double cropping (ratoon cropping) is not a safe practice in Arkansas in most years (*64*).

However, even the customary April seeding often is subjected to unfavorable conditions for establishing stands. Varieties that have short growing seasons mature during hot weather if seeded at the average time, and in some seasons the quality is poor. Localized summer wind storms and rainstorms may cause lodging with resulting loss of yield and increased cost of combining. Often at the peak of the season more rice is ready for harvest than the driers have capacity to process, and the rice that waits in the field is in danger of deteriorating.

Rice matures in a shorter time when sown late than when sown early. Delaying seeding or using varieties that require long growing seasons permits harvesting to be done in the normally cool autumn weather when there may be fewer showers and when the driers are less likely to be crowded. Later maturing rice usually is better quality as long as the temperatures are not too low for normal development of the grain. Delaying seeding also allows time for additional cultivation to reduce weed and red rice infestation. On land that has been in winter or perennial pasture crops, a delay in date of seeding provides a longer grazing period and makes possible the preparation of a better seedbed.

Late seeding also has disadvantages. There may be a greater possibility of injury by root maggots, armyworms, and stem borers. Weather conditions may be more favorable to the blast fungus at the time the young plants are susceptible. Stem rot may be more severe late in the season. The crop is exposed to early fall storms, likely to be the most damaging of the season. Cold weather may reduce quality and yield if harvest is extremely late. Isolated late-maturing fields probably are more exposed to damage by concentrations of birds and other pests than are extra early fields.

Clearly, there is no ideal time for seeding. In Louisiana and Texas especially, where the seeding period is long and there are several varieties to choose from, the date of seeding demands careful consideration. This is true whether one field is to be seeded to a single variety or a large acreage is to be allotted among two or more varieties.

Rate of Seeding

Factors that enter into a determination of the proper rate of seeding include seed size and quality, condition of the seedbed, fertility of the soil, date of seeding, and variety. In the southern rice area, the seeding rate is about 90 to 110 pounds per acre when drilled and about 115 to 150 pounds per acre when sown broadcast on dry soil or in the water. In California, when rice is sown in the water, seeding rates average about 150 pounds and range from 125 to 200 pounds (dry weight basis) per acre.

The number of rice seeds ranges from 14,000 to 22,000 seeds per pound, depending on the variety. With a seeding rate of 150 pounds per acre, seeds are sown at the rate of about 50 seeds per square foot. Excellent yields have been obtained from populations ranging from 8 to 30 plants per square foot. Seeding rates that provide plant populations between these extremes apparently do not influence yields. Extremely dense stands lodge more readily than do optimum stands. Rice in dense stands heads and matures more uniformly than does rice in thin stands with abundant tillering. Weed control is more difficult in thin stands, so seeding rates should be higher in fields infested with weed seed. Relatively high seeding rates usually are used on land on which many rice crops have been grown previously.

In early tests in Arkansas, Nelson (*93*) tried 11 rates of seeding, using recleaned seed, seeded with a grain drill. The results showed no marked preference for any rate. Although denser stands and fewer weeds were obtained from the higher rates of seeding, higher yields resulted from the

lower rates of seeding. The highest average yields were obtained from sowing approximately 70 pounds of seed per acre.

Simmons (*115*) reported that later studies at the Arkansas Rice Branch Station at Stuttgart indicated that the best rate for drill seeding was 90 to 110 pounds per acre and that about 110 to 135 pounds per acre was best when the seed was broadcast.

Chambliss (*18*), reporting on early experiments at the Crowley, La., Rice Experiment Station, found that the largest yields and the best quality of milled rice were obtained from the Honduras variety by drilling 80 pounds of seed to the acre. Other varieties available at that time could be seeded at a slightly lower rate. He pointed out that less seed may be used when the crop is sown in late May if the seedbed is well prepared, since better germination is obtained with higher temperatures prevailing. The quantity to be sown depends on the method of seeding, variety, character of the seedbed, soil fertility, and vitality or germination of the seed. If rice is broadcast on wet land or on a poorly prepared seedbed, the rate of seeding should be increased. If seed of low vitality is used, then the seeding rate should be increased accordingly. Seeding at too low a rate resulted in excessive tillering, irregular ripening, and reduced grain yields.

Reynolds (*105*) stated that in Texas the rate of seeding ranges from 60 to 125 pounds per acre, with the average about 90 pounds. The rate of seeding varies greatly in different parts of the rice belt of Texas. In the more humid areas, higher rates of seeding are used than in the western counties where rates as low at 60 pounds per acre frequently are used. At Beaumont, from 1914 to 1918, seeding 100 pounds per acre produced slightly higher yields of rough rice than seeding 60 and 80 pounds per acre. Experiments were conducted there from 1950 to 1952 to determine the optimum rate of seeding rice under several levels of soil fertility. Bluebonnet 50 was broadcast at rates of 45, 90, 135, and 180 pounds per acre. Fertilizers were applied on the surface with a fertilizer-grain drill at the time of seeding. There were no significant differences in the average yields of rough rice from the seeding rates of 90, 135, and 180 pounds per acre, but the yields from these rates were significantly higher than those from the 45-pounds per acre rate. As in earlier experiments, the optimum rate of seeding was about 90 pounds per acre. Where weeds are troublesome, heavier rates of seeding usually give better results.

Jones and others (*69*, *70*), summarizing rate of seeding experiments with drilled rice under favorable conditions, indicated that 80 pounds of seed per acre usually is sufficient to give good stands. Yields are seldom materially increased and sometimes may be reduced if more than 80 pounds per acre is sown. They pointed out that under ordinary conditions, 90 to 100 pounds of recleaned viable seed sown with a drill or 110 to 150 pounds sown broadcast is sufficient to give good stands. They stated that the rate of seeding should be sufficiently high to produce stands that are thick enough to help check weed growth and also to prevent late tillering. The latter often results in irregular ripening and grain of inferior quality.

Method of Seeding

Several methods are used to seed rice in the United States. On dry soil rice may be sown 1½ to 2 inches deep with a grain drill, or broadcast and disked or harrowed to cover. When soil moisture is not sufficient for germination and growth, the field may be flushed. The water is drained immediately because the rice seedling cannot emerge through both 1 to 3 inches of soil and 4 to 8 inches of water. Rice also is broadcast in water by airplanes (fig. 33). Several modifications of the water-seeding method are used. Rice is not transplanted in the United States.

Simmons (*115*) reported in 1940 that the two methods of seeding being used in Arkansas at the time of his report were the broadcast and the drill methods. The broadcast method had been most popular since it did not require much machinery, and it was used extensively in new rice areas. He pointed out that drilling was being used widely

FIGURE 33.—Airplane being loaded with seed rice, with tanks used for soaking seed in the foreground, and ricefields ready to be seeded on each side of landing strip.

on old riceland. Advantages of drilling over broadcast seeding were that less seed was required for a good stand and that the seed could be put down at a uniform depth and rate, which make a more uniform stand possible. Simmons pointed out that uniform stands are important because they insure even maturity. Grain maturing evenly will have a better grade, and consequently will usually command a better price. He further stated that when rice was seeded with a grain drill, a depth of 1 to 2 inches normally should be used. Deeper seeding sometimes resulted in a poor stand, especially if the soil was clay textured, cold, or inclined to crust after rains.

Jones and others (*69*) also reported that shallow seeding is preferable to deep seeding on a rough seedbed or a fine mellow seedbed that is inclined to crust after rain. Surface crusts may be broken by a light harrowing or by irrigating to permit the seedlings to emerge.

Nelson (*94*) reported in 1944 in Arkansas that seeding rice broadcast on the surface of the soil and irrigating immediately gave large increases in yields of rice over the usual method being used at that time. He pointed out that even larger average increases in yield were obtained when the soil was flooded and the seed broadcast in the water. He indicated that both methods could be used to produce higher yields of rice if the practical difficulties involved in seeding large areas by these methods could be overcome. The yield increase apparently was due to the control of grass.

Mullins (*89*) found that in Mississippi, where ground equipment was common, rice was seeded after the first levee-building operation was performed and before the levees were raised to the desired height. Seeding was done with endgate seeders by approximately 50 percent of the farmers who were surveyed, and grain drills were used by the remainder of those using ground equipment. By 1958, about 20 percent of the farmers seeded some rice in the water with planes, and the practice appeared to be more common in 1959. Water seeding often was used during the later weeks of the planting season when quick germination and effective grass control are particularly important. Some farmers reseeded their levees after the final levee-building operation, but the majority did not.

Reynolds (*105*) reported that a depth of 1 to 2 inches was best when rice was seeded with a grain drill. In experiments conducted at Beaumont, Tex., from 1914 to 1918, placing the seed 2 inches deep produced slightly higher yields of rice than placing the seed 1 or 3 inches deep. There usually was less rotting from shallow seeding than from deep seeding, especially if irrigation was necessary to germinate the rice seed. Seed could be planted deeper on sandy soils, such as Katy and Hockley soils, than on clay soils, such as Beaumont clay and Lake Charles clay.

Reynolds (*105*) pointed out that rice usually was seeded in Texas with a grain drill but that aerial seeding was increasing rapidly and that 110,000 acres were seeded by plane in 1953. He stated that broadcast seeders were used to some extent. On rough, dry seedbeds, rice frequently was broadcast with endgate seeders or with a drill with the disks removed. In either case, the land was then harrowed after seeding and was irrigated. When seeding was done on dry land, fields usually were harrowed after seeding and then flushed to bring about germination. The fields were resubmerged in time to control the growth of weeds and grass.

The seeding of rice in water was started in California as a way to control barnyardgrass (*Echinochloa* spp.) (*6*). At first rice was sown with a tractor-drawn endgate broadcast seeder, but this method was not very satisfactory. Airplane seeding was attempted first near Merced, Calif., in 1929, for reseeding a field of rice. A fair stand of rice and a satisfactory yield were obtained. Several growers in California seeded their rice from an airplane in 1930. Now airplane seeding is the common practice on California's 300,000 acres of rice.

According to Finfrock and Miller (*36*), the usual practice in California (1964) is to soak the seed for 18 to 24 hours in a sodium hypochlorite solution (see "Seed Treatment," p. 85), drain for 24 to 48 hours, and seed by airplane into fields that have just been flooded to a depth of 6 to 8 inches. Seed rice will absorb the maximum amount of water in 18 to 24 hours.

Soaked seed is used instead of dry seed. Soaking starts the germination process before seeding. More important, because it is heavy, the soaked seed sinks into place when it hits the water. Thus the seed does not drift and unseeded areas are not left in the field. Fields remain continuously flooded until drainage for harvest.

Modifications of water-seeding methods broadly adapted to use in the sourthern rice area have been developed. Slusher (*119*, *120*) extensively discussed the use of aircraft to seed rice in Arkansas.

Adair and Engler (*6*) described the water-seeding method as used in Arkansas as follows: The land usually is plowed in winter and a seedbed is prepared in the spring by disking two or three times and then harrowing. Frequently, the soil also is tilled to a depth of about 8 inches with a field cultivator to provide aeration and space for applying cool irrigation water that contains dissolved oxygen. Oxygen is essential for early root development. The levees are completed after the soil is worked with the field cultivator and the field is then cultivated between the levees with

a spring-tooth harrow, which leaves shallow furrows and ridges that help to reduce drifting of the seed. The levees may or may not be seeded before final going over with the levee disk. Floodgates are then put in, the field is submerged to a depth of 4 to 6 inches, and the rice is sown from an airplane. Seeding is done as promptly as possible, since poor stands usually are obtained when the water has been on the field longer than about 4 days before seeding.

The airplane operator is guided by flagmen, one at each end of the field, who pace off the distance (about 30 feet) that the plane can sow in one trip across the field. Depending on the length of growing season of the variety being grown and the desires of the operator, the water may be drained from the field after 5 weeks or more to control the rice water weevil, to prevent straighthead, or to provide dry soil for topdressing with fertilizer (*6*). Occasionally, draining at an earlier date may be necessary. However, unless specific conditions exist that require early draining, it is advisable to drain late because high grain yields have been obtained when flood water was left on fields until shortly before harvest (*93*).

From tests with water-seeded rice on clay soil in Arkansas, Hall (*50*) suggested the following:

(1) A disk harrow is effective in preparing the seedbed. On the last trip over, a spring-tooth harrow should follow the disk harrow so that prominent furrows are left in the seedbed to catch the seed and reduce the drift.

(2) The field should be flooded as rapidly as possible with a minimum of 4 to 6 inches of water to control grass. All levees should have a gate or spillway so as to make and maintain a constant level of water and prevent the levees from breaking because of added pressure from heavy rains.

(3) The field should be seeded immediately after the 4- to 6-inch depth of water is obtained. In the test conducted, there was no significant difference in plant stand densities obtained due to seeding in clear or in muddy water that cleared within 24 hours after seeding. Likewise, presoaking the seed showed no significant difference from seeding with dry seed. It was found that seed treated with a fungicide or insecticide, or both, had less tendency to float than did untreated dry seed.

(4) After seeding, the full flood of 4 to 6 inches of water should be maintained for 5 to 6 weeks. Lowering the water depth or draining the field soon after seeding allows grass to become established with the rice, thus defeating the purpose of water seeding. A rate of 135 pounds of seed per acre gives a sufficient number of plants, so that the loss due to wave action is much less than loss from weeds due to draining the field.

(5) After a period of 6 weeks or more, the field may be drained for midseason nitrogen fertilization.

A few growers in Arkansas pregerminate the seed by soaking it before seeding. In one method the seed is placed in a grain cart such as that used to haul the rice from the combine at harvesttime. The grain cart is filled with water, or water is kept running through the seed for several hours. Then the water is drained and the rice is left in the grain cart overnight. The following day it is augered into the hopper of the plane for seeding. In another method the seed is soaked in bags in a canal for a somewhat longer period, up to 36 hours.

Faulkner (*34*) compared different practices for water seeding rice in Louisiana. These included (1) pregerminated seed compared with dry seed, (2) cloddy seedbed compared with seedbed that had been smoothed in water, and (3) draining irrigation water 3 to 5 days following seeding compared with leaving a full flood of water and allowing the rice to emerge through the water.

He reported slightly higher grain yields when the seed was soaked to pregerminate it before seeding in the water. He found that a small percentage of the dry seed floated in the water and settled in low spots, whereas the pregerminated seed remained well in place on both the cloddy and smooth seedbeds. However, he pointed out that pregerminating seed requires additional labor and expense and also requires a short interval between germination and seeding.

Faulkner found that the average yield of rice produced from the smooth or the rough seedbeds was approximately the same. However, there were some indications that the working of the soil in water reduced the germination of grass seed and thereby reduced the resulting competition. Also he found that soils that were worked in the water dried more quickly when the water was drained and caused the top one-fourth inch of soil to curl, thereby pulling the young seedlings from their root anchorage. Such conditions would require that the area be flushed.

In this series of experiments, Faulkner found that good stands of rice, along with excellent control of red rice and grasses, could be obtained by leaving a full flood of water on the field until the rice had emerged through the water and was strong enough to stand free from the water. The yield results from 1959 indicated that about 500 pounds more rice per acre was produced where the water was allowed to remain on the field than where it was drained a few days after seeding. Faulkner thought that on the clay soils it might be more difficult to obtain a good stand of rice using the continuous flooding method, but

that additional experiments would be necessary to determine this.

The most common method of land preparation for water seeding in Texas in 1954, according to Reynolds (*105*), was plowing and disking to kill the vegetation. The land was then left in a rough condition until seeding, at which time the field was irrigated until the water barely covered the land. It was then harrowed to muddy the water. Harrowing to muddy the water before seeding is seldom done early in the season, because dry north winds cause the soil surface to dry rapidly. This drying curls and cracks the soil surface before the seedlings become rooted. The seed usually was soaked in bags in a canal for 24 to 36 hours, removed from the water and allowed to drain, and then sown by airplane on the water. Some farmers drained their fields as soon as possible after sowing, whereas others might delay draining as much as 36 hours. Experiments conducted by Wyche and Cheaney (*150*) during 1954 at the Rice-Pasture Research and Extension Center showed that under the conditions of the test, soaking the seed, muddying up the water, time of removing the water after seeding, and depth of the water up to 8 inches had no effect on the yield of water-seeded rice. They felt that it would be a good farm practice to leave the surface of the soil slightly rough in order to lessen the drift of seed when water seeding rice.

From observations made on experimental tests and on commercial fields, little if any difference in suitability to water seeding has been noted among varieties. However, in Arkansas where the soils are alkaline, or the water contains excess salts, the medium-grain varieties in general have been damaged less from these adverse conditions when water seeded than have the long-grain varieties, especially the Bluebonnet group. Hall and Thompson (*51*) pointed out that these problem areas that are colloquially referred to as alkaline have been brought about, on cultivated lands, by the use of well water containing excess salts combined with restricted internal drainage of the soil. Some of these troublesome soils have shown a pH of 7.0 to 7.5, whereas others have been below 7.0. This indicates that pH alone is not a completely reliable indicator of such problem soils.

Nelson (*92*) conducted an investigation to determine the uniformity of distribution of seeds and fertilizers from airplane distributors and studied the extent to which rate of application, materials distributed, and flight altitude affected uniformity of distribution. He concluded that a fairly good distribution is possible with well-designed equipment if a few precautions are followed. Characteristic deposit patterns should be determined before a new or modified distributor is first used. From the deposit patterns obtained, optimum flagging intervals can be determined that will allow for an overlap sufficient to maintain a uniform application or seeding rate. For proper overlapping of swaths, a ground crew is necessary. For uniform distribution a flagman should be stationed at each end of the field, and each flagman should be equipped with two long markers connected with a rope or chain length equal to the flagging interval distance. It is necessary that the flagging interval be measured correctly and that the airplane fly directly over the two flags. Recently, many growers have measured these flagging distances or intervals and have marked them with stakes or small flags on wires so that the flagman will not need to measure the distance.

Transplanting Rice

Yields of direct-seeded and transplanted rice were compared in a study conducted by Adair and others (*7*) in the major United States rice areas during a 3-year period starting in 1937. Three varieties were included in the experiment at three rice experiment stations in the Southern States, and two varieties were included at the California Rice Experiment Station. High yields of transplanted rice often obtained under intense culture in certain countries had led to a more or less common belief that yields of transplanted rice generally are higher than those from direct seeding. Advantages claimed for transplanting were listed and discussed. It was pointed out that high-quality, stiff-strawed varieties already were being grown by machine methods in several countries. During the 3 years of these tests, the average yields of some of the varieties at some locations were significantly higher from direct seeding than from transplanting. None of the varieties at any of the stations produced significantly higher average yields when transplanted than when directly sown. These workers concluded that the principal reasons for transplanting are not to increase yields but to better use land and labor in densely populated countries in which the tillable land area is limited and the labor supply is plentiful.

Irrigating and Draining

Flood irrigation is used for all rice grown in the United States. The soil is submerged in 4 to 8 inches of water most or all of the time from seeding or shortly after, until the grain is nearly ripe. This period may extend from 60 to 90 or more days, depending on method of seeding and variety grown (*8*, *69*). Although the water requirement for rice is high, Jones and others (*69*) stressed that good surface drainage is as necessary for successful rice culture as is a dependable supply of fresh irrigation water.

Haskell (*52*) pointed out in 1915 that a plentiful and easily accessible water supply is the first requisite where rice is to be grown. He also emphasized the importance of proper use of available water. He suggested that under certain conditions, it was beneficial to control the flow of fresh water so that it traveled the entire length of each cut. This circulation resulted in more uniform water temperature and helped to control algae (scum) and insects. He also stressed the importance of judicious water management in reducing the effects of certain diseases and other production hazards.

Amount of Water Required

The water requirement of the United States rice crop is comparatively high because the fields are continuously flooded for so much of the growing season. Rice will not produce a profitable crop on stored soil moisture or infrequent rains, as will other cereals (*8*). When tried in the United States or when used elsewhere, the upland system of rice culture generally results in yields of only 30 to 70 percent of those obtained from flooded rice grown under similar soil and climatic conditions.

Senewiratne and Mikkelsen (*114*) suggested that differences in growth responses of flooded and unflooded rice may be due to differences in auxin metabolism. They found that plants grown under unflooded conditions had a low catalase activity and a high peroxidase activity, which favored accelerated auxin degradation. They suggested that high manganese levels in plants grown under unflooded conditions affect the indolacetic oxidase mechanism and result in retarded growth and depressed grain yields. Rice grown with ammonium nitrogen (flooded) collected small amounts of manganese, whereas plants grown with nitrate nitrogen (typical of upland rice) contained much more manganese. Clark, Nearpass, and Specht (*21*), however, concluded that "the better growth of rice in submerged as compared to upland culture in at least some soils is due to greater Mn availability under submerged soil conditions."

Jones and others (*69*) indicated that from 2.8 to 3.8 acre-feet of water normally was required to produce a rice crop in the Southern States. About one-third of this is supplied by rainfall during the growing season. Robertson (*106*) reported from early observations that the total seasonal use of water for rice in California normally ranged from 4.3 to 14.8 and averaged 8.2 acre-feet. After a ricefield is flooded, a considerable amount of water is required to maintain an optimum depth in the field. Water is added periodically to compensate for losses due to transpiration by plants, evaporation from the water surface, deep percolation, and spillage. These losses will vary, depending on amount of plant growth, solar radiation, temperature, wind, relative humidity, soil type, and rate of inflow of water into the field. A rate of flow equal to 1 cubic foot per second (450 gallons per minute) for each 50 acres being irrigated usually is required to maintain water levels on ricefields in California (*37*).

The apparently lower water requirement for rice in the Southern States as compared to California is related to naturally occurring climatic differences in the evapotranspiration losses from ricefields between the two areas. Whereas the relative humidity during the growing season is quite high in the Southern States, it is comparatively low in California. In California, a vegetation-free water surface will lose from 5 to 6 acre-feet in 12 months, whereas this loss in southern rice areas may be less than half this amount.

Source of Water

It is estimated that 30 to 35 percent of the 1962 rice acreage in the United States was irrigated from wells. Adair and Engler (*6*) stated that over 40 percent of the 1953 rice acreage received well water. Since that time, however, numerous additional reservoirs have been constructed. Many of these reservoirs were constructed in Arkansas. The reservoirs are filled with runoff water before the ricegrowing season. Other important sources of irrigation water are rivers, bayous, lakes, and drainways.

Adair and Engler (*6*) discussed the early irrigation of rice and reported that in 1894 the first large irrigation plant was established near Crowley, La. After failures of some pumps, a somewhat larger centrifugal pump was installed in 1896. This pump delivered 5,000 gallons of water per minute, which was enough for the rice acreage planted at that time. During the next few years, many pumping plants were installed on the streams in southwestern Louisiana and southeastern Texas. By 1901 some pumping plants in operation delivered up to 45,000 gallons of water per minute.

Diesel engines came into common use for pumping water after 1919 (*6*). Convenience, low labor requirements, and reasonable initial and operating costs have since caused a shift to electric power and natural gas power for irrigating rice. In Arkansas in 1955, nearly 50 percent of the 1,800 irrigation installations were powered by electricity. In Louisiana, of a total of 1,061 wells, 450 were powered by diesel engines, 212 by natural gas, 105 by electric motors, and the remainder by other units. In some cases water is pumped or relifted by means of the power take-off unit on tractors.

Historically, most areas in the world where water is pumped from wells have experienced declining water tables. This problem, as related

to Arkansas rice production, was studied by Engler, Thompson, and Kazmann (*30*). Suggested remedies included the use of deep wells (900 to 1,000 feet) that normally supply more water than shallow wells (100 to 150 feet) and the use of small reservoirs. Engler (*29*) reported that during a 30-year period, the decline in water level for the Grand Prairie area of Arkansas averaged about three-fourths foot per year, which caused an annual decline in capacity of shallow wells of 20 to 25 gallons per minute. Various methods of replenishing underground water supplies on the farm are discussed by Muckel (*87*).

Gerlow and Mullins (*42*) pointed to the value of small, 20- to 40-acre farm reservoirs in conserving surface runoff water to supplement or replace well water for rice irrigation. Another development designed to conserve water (whether from wells or elsewhere) has been the increasing use of underground concrete or lucite irrigation pipelines (laid about 30 inches beneath the soil surface) to transport irrigation water for rice and the accompanying rotational crops. Pipeline irrigation greatly reduces the rodent damage that characterizes open irrigation systems. In addition, it greatly reduces evaporation and seepage losses. Aside from the important aspect of water conservation, it has been calculated that, for each 1,000 feet of open canal replaced with a pipeline, 2.8 acres of land are returned to crop production (*3*).

Adair and Engler (*6*) pointed out that pumping from bayous supplies most of the surface water in Louisiana and Texas. According to Anderson and McKie (*11*), sources of rice irrigation water in Mississippi are shallow wells (90 to 100 feet) and surface water from lakes or streams. Diversion from large streams is the main source of water for rice irrigation in California. It is estimated that less than 5 percent of the California rice acreage is irrigated from wells.

Quality of Water

For successful rice production it is very important that the available water be of suitable quality. Rice irrigation water should be relatively free of dissolved salts that are toxic to rice plants. The characteristics of irrigation water that determine quality include (1) total concentration of soluble salts; (2) relative proportion of sodium to other cations; (3) concentration of boron or other toxic elements; and (4) under some conditions, the bicarbonate concentration as related to the concentration of calcium plus magnesium. Other important factors to consider are the initial salinity of the soil, the effect of internal drainage on the flooded soil, and the total salt content of the soil. Finfrock and others (*37*) described good-quality rice irrigation water thus:

Specific Electrical Conductivity ($K \times 10^6$)	less than 750
Boron, parts per million	less than 1
S.A.R. index (tendency to form alkali soil)	less than 10.0

When high sodium water is regularly used each growing season, it may deflocculate the soil, so that stickiness, compactness, and impermeability increase. The deflocculated soil is difficult to cultivate and usually produces low yields.

Pearson (*96*, *97*) described the point of greatest importance as the nature of the soil solution or saturation extract found in the zone of rice roots. If soil saturation extracts have a conductivity index of 4 to 8 millimhos, the yield of Caloro rice may be reduced 50 percent.

Rice is very tolerant of salt during germination, but rice seedlings are very sensitive to salinity during early development (1 to 2 leaves) and are progressively less so at 3 to 6 weeks of age (*96*, *99*). When soils are strongly saline, having an excessively high concentration of sodium, calcium, or potassium, the concentration of salts in the soil solution (including the standing water) may be so great that it will injure or kill the seedling rice (*98*). Excessive salt concentration results in restriction in downward percolation; therefore, the floodwater is subject to a longer period of evaporation with an ensuing increase in salt concentration. Thus, water having a higher salt concentration enters the soil, and the salt concentration of the soil solution is increased.

Adair and Engler (*6*) reported that salt water put on dry soil damages a ricefield more than if salt water is used to replenish the water supply in a field that has been watered with fresh water. The reason given was that the salt was more concentrated in the dry soil, and more of it moved into the root zone, where it was taken up by the plants. They indicated that rice grown on clay soils may not be injured as much by salt water as is rice grown on lighter soils, because less water is used and less is lost by seepage.

The rice plant can tolerate higher concentrations of salt in the later stages of growth, although very high concentrations may kill the plants or make them sterile. Some varieties of rice are more tolerant to salt than are others and may make satisfactory yields when the water contains salt concentrations of 75, 150, 200, and 250 grains per gallon in the tillering, jointing, booting, and heading stage, respectively. It is believed that some of the newer varieties would be damaged seriously by such amounts of salt (*6*).

Irrigation water pumped for rice from shallow wells in Arkansas and other States frequently has a comparatively high sodium con-

tent as compared with water coming from surface streams. Kapp (*71*) suggested that the source and chemical composition of rice irrigation water should be considered from both the immediate effect on the current crop and the long-range productivity of the soil. In greenhouse and field experiments he found that sodium chloride added to rice soil injured germination and resulted in lowered production of vegetation and grain. The addition of 5,700 parts per million of sodium chloride to the soil only slightly reduced vegetation, but completely prevented grain formation. In field trials, 825 pounds of sodium chloride per acre hindered germination, and 3,300 pounds per acre reduced rice grain yield.

Water from the shallow wells in Arkansas containing 75 parts per million calcium and 22 parts per million magnesium has caused some riceland soils to increase in alkalinity from an original pH of about 5.0 up to as high as 8.0. The change from a highly acid to a highly alkaline reaction is due to the annual addition of about 1,500 pounds per acre of limestone equivalent. The increase in alkalinity has lowered the availability of phosphorus in the soil. If a new source of water low in dissolved minerals is obtained, such changes may be reversed (*6*). Such water may be obtained from installing a deep well or constructing a reservoir and catching surface runoff water. However, as long as the unfavorable soil condition exists, delaying the initial flood and following a routine of alternate draining and reflooding at 4- or 5-day intervals until the plants are about 6 weeks old have given fairly satisfactory relief in Arkansas.

When the rainfall is below normal in the Gulf Coast area of Louisiana and Texas, the water level in the streams that supply irrigation water often is so low that brackish water encroaches from the Gulf. The concentration of chloride salts may become so high that the yield and quality of rice is reduced or the crop is ruined. Adair and Engler (*6*) pointed out that several workers had shown that water containing more than 35 grains of salt per gallon (600 parts per million) should not be used to irrigate young rice if the soil is dry and if the water is to remain on the field. Rice watered continuously with water containing 35 and 75 grains of salt per gallon was reduced in yield about 25 and 70 percent, respectively, and the rice was of lower quality than when water containing only 25 grains per gallon was used.

Water quality in California ricefields was studied by Stromberg and Yamada (*135*). They found that water that contained a high total of soluble salts killed rice plants. However, when a field showing initial symptoms of dying was immediately flushed out with quantities of water low in total salts, the plants soon recovered. Water low in total salts was used for the remainder of the season, and a normal crop of grain was produced.

In California, rice culture has proved useful in reclaiming saline soils, provided the fields to be reclaimed are first engineered to drain well. Mackie (*77*) reported that one rice crop grown in Imperial clay near Imperial, Calif., reduced the saline content 72 percent to a depth of 6 feet. In his experiments he found the usual reduction in saline content from the first rice crop to be one-third to two-thirds. Overstreet and Schulz (*95*), in a series of San Joaquin Valley tests, concluded that rice culture serves as an efficient means of reclaiming nonsaline soil containing 15 percent or more of exchangeable sodium.

Water Temperature and Oxygen Content

The temperature of water with which rice is irrigated has a profound effect on the plants. Adair and Engler (*6*) reported that the temperature of rice irrigation water pumped from wells and from streams frequently is 65° F. or lower. When such cool water goes directly into the field, the rice growing near the water inlet usually is retarded and may ripen as much as 7 to 10 days later than the rest of the field. Raney, Hagan, and Finfrock (*103*) showed that with the building of high dams on the major California streams, the temperature of water available for rice irrigation from surface streams had dropped to 51° or less.

The temperature of the irrigation water should be not less than 70° F. nor more than 85° for best results. Raney (*102*) showed that the critical seasonal threshold of water temperature for normal growth of Caloro rice was near 69°. When the mean temperature was 5° lower, maturity was delayed 30 days beyond the normal 160 days. Rice yield was highest when the mean water temperature was 80°. At water temperatures above 85°, yield was reduced and root development was poor, probably because of low oxygen content of the water.

Chapman and Peterson (*20*) studied underwater rice seedling establishment in relation to temperature and dissolved oxygen. Under laboratory pot culture they found water temperatures in the range of 77° to 84° F. most favorable for the effective establishment of rice in static culture. Emergence of the shoot from the water was most rapid at 84°, but the development of the root system and the penetration of the soil were favored by temperatures as low as 68°. Exposure to a water temperature of 104° for 12 hours or more was lethal to pregerminated Caloro rice seed. They concluded that it seemed unlikely that dissolved oxygen deficiency would

FIGURE 34.—Headgate that controls flow of water from canal into ricefield.

be a limiting factor in seedling establishment in the field even at 95°, if currently recommended seeding rates were used and the water had an initial oxygen content of at least 5 to 6 parts per million.

Ehrler and Bernstein (*28*) reported that at a constant root temperature of 64.4° F., Caloro shoot growth was twice that at 86° and root growth was one and a half times as great; however, grain yield was only three-fourths as much at the lower root temperature. No significant interaction was found between root temperature and cationic concentration or cationic rates.

Seeds germinate slowly when the temperature is less than 70° F. Water now available for rice irrigation in some areas, including northern California, may be colder than this, ranging down to 51° or less. Such cold water will retard and lower the germination of rice sown in the water and will retard the development of plants so that the stand may be thin and crop maturity will be delayed near the inlet to the field. According to Raney, Hagan, and Finfrock (*103*), field studies over a 3-year period showed that plant-free water-warming basins, 6 to 12 inches deep, equal in size to 2 percent of the area to be served, successfully and economically raised the mean water temperature of 60° to 70°.

Water Control Methods

Methods of transporting and controlling irrigation water for rice production have evolved over the years. They vary in different rice-producing areas but tend to follow a general pattern.

In most cases water is conveyed from the pumps, streams, or reservoirs in canals from which it is diverted into laterals, into field ditches, and finally into the field checks or paddies. Water is usually delivered to the highest point in the field by canals or pumps. It passes into successively lower paddies through metal levee gates or levee control boxes or openings in the levees. These gates or boxes provide permanent control of maximum water depth in each paddy.

Water that overflows or is drained from the

lowest paddy may be caught in drainage ditches or canals and recirculated or moved into other canals or drainage ditches. Some fields have a canal along one side so that each paddy can be watered separately from this canal. Finfrock and others (*37*) described in detail the rice irrigation control structures used in California.

Canal Gates.—Gates in the irrigation canals of the California ricegrowing areas are simple structures of wood or concrete (fig. 34). In the vertical fixed portion of the structure, slots are provided so that short planks (flash boards) can be inserted or removed as desired to raise or lower the water level at the diversion point into the field. Inlet structures to the field may consist of similar slotted wooden structures or screw-type metal gates. The latter commonly are used in the southern rice area.

Levee Boxes or Gates.—Water is controlled within the field with boxes or gates set at convenient locations in the levees. In the southern rice area, metal levee gates with adjustable panels are in common use in some localities (fig. 35). Variations that may be used include single planks or boards or metal panels which are forced into the soil across a narrow cut through a levee to keep the water at the desired level. In California, the levees are usually considerably larger than those in the Southern States. The wooden or metal boxes are placed along the more accessible side of the field. Flash boards of various widths are added or removed to regulate the water to the desired depth. Boxes must be properly constructed and installed so they will not be washed out (fig. 36).

Depth Stakes.—To gage the water level in a paddy or check, a depth stake is driven into the soil within a suitable distance of the levee box or gate. The stake is set so that the bottom of an 8-inch red band is at the average elevation of the ground surface in the paddy. If a 5-inch flood is desired, then 3 inches of the red band is

Figure 35.—A ricefield in Arkansas that is irrigated and ready to be seeded, showing the gates used to regulate the flow of water from one check to another. (Photo by Copeland.)

FIGURE 36.—Levee box used in California to regulate flow of water from one check to another in ricefield.

left showing. The stake is painted white at the top, so that if an 8-inch flood is desired, only the white band is left exposed.

Construction of access roads around ricefields helps to (1) cut production costs because equipment can be moved more easily into the field; (2) control water better and more economically; and (3) control mosquitoes by reducing seepage problems, by making it easier to control weeds where mosquitoes breed, and by enabling mosquito abatement employees to reach troublesome spots.

PROTECTION OF IRRIGATION SYSTEM.—Once they are engineered and installed, riceland irrigation and drainage structures are subject to damage from use, the elements, and insect or animal pests; but countermeasures can be employed. In large, flat paddies or checks, wind levees may be constructed between the normal-interval levees to decrease wave action. Their judicious placement in areas subject to strong winds may be very beneficial. So-called alkali levees built from soil high in sodium and other salts frequently are subject to washouts or breaks when fields are flooded. Heavy applications of gypsum on such areas before pulling the levees help to stabilize the soil and greatly reduce the chances of breaks. Plastic sheeting or various types of laminated paper also can be used to cover weak areas in levees. Soil is plowed or shoveled onto the edges of the material to prevent its floating when the field is flooded. Certain pests, such as muskrats, field mice, Norway rats, crayfish, and large insects, often inhabit canal and drainage ditchbanks, as well as contour levees. Their burrowings may result in levee or bank leaks or breaks and heavy water loss. Major structures, such as weirs, can be protected to some extent by trapping or poisoning the pests. In California fields where the large levees sometimes are inhabited by crayfish and muskrats, the problem has been solved by using sheep to graze the vegetation from the levees.

Water Management

The application and management of water is a key operation in rice farming (*89*). The principal functions of water cover are to control weeds, to condition the soil and provide a favorable environment for rice growth, and, especially in California, to serve as a temperature regulator by minimizing the effect of the large variations between daytime and nighttime air temperatures.

Systems of water management for rice production vary widely, depending on method of seeding, soil type, climate, crop rotation, diseases, and insects. A very important aspect of water management is good drainage. This includes drainage of winter rainwater as well as periodic drainage during the growing season. In years when riceland is used for rotational crops, the crops may be drowned if drainage is poor. Seedbed preparation and fall harvest can be expedited by a good drainage system. Drainways around and through the field that connect with main drainage ditches leading to natural drainage channels are essential. These ditches should be large enough and deep enough to allow the removal of large quantities of water quickly. When it is necessary to preirrigate or to flush irrigate to bring about emergence of rice, good drainage plays a key role in getting a good stand quickly by expediting fieldwork and reducing seed rot losses (*8*, *69*). Good drainage of ricefields and adjacent areas and ditches also is of prime importance in eliminating mosquito-breeding areas.

Essentially there are two broad systems of water management, depending on the method of seeding. The first broad system of water management revolves around drilling or broadcast seeding on "dry" ground. Where necessary, seeding is followed by flushing to bring about uniform emergence, and the first flood is applied later. This system is often used in the southern rice area. With the second broad system of water management, fields are flooded just before aerial seeding and usually remain flooded until they are drained for harvest. This system is used in California, and with modification also is used in the southern rice area. In the southern rice area (especially in Texas), where rice is water seeded on heavy soils, some growers drain as soon as possible after seeding; others may delay draining for 36 hours. After stand establishment, irrigation practices are essentially the same as for drilled rice (*8*).

Unless rice is water seeded and the flood is maintained, a flood is applied about as soon as the

crop is old enough to withstand submergence. As a means of weedy grass control, ricefields on the lighter soils in Arkansas often are flooded as soon as the rice has emerged. If the fields are free of weedy grasses or if these grasses have been chemically controlled, the land may not be submerged until the rice seedlings reach a height of 4 to 6 inches. Jones and others (*69*) indicated that at this stage the land is submerged to a depth of 2 to 4 inches. As the plants grow taller, the depth of water gradually is increased until it reaches 4 to 6 inches. During the rest of the growing season or until the land is drained before harvesting (except for special reasons), the water may be held on the land at a depth of about 5 inches. To maintain this constant depth, additional water should be applied to replace that lost by evaporation, transpiration, and seepage.

Reasons for draining ricefields during the growing season and allowing the soil to dry include (1) control of algae (scum); (2) control of rice water weevil; (3) prevention of straighthead (blight); (4) control of aquatic weeds such as mudplantain (ducksalad); and (5) application of nitrogen fertilizer. On saline or alkaline soils it may be necessary to drain fields several times early in the growth of the rice to allow the plants to become well established.

Arkansas.—Adair, Miller, and Beachell (*8*) reported that water management is similar in Arkansas and Louisiana. Depending on growing conditions and grass control methods being used, the first flood may be applied as the rice is emerging, or it may be delayed for 2 or 3 weeks. The majority of ricegrowers in Arkansas drain their fields about midway in the growth of the rice and allow the soil to dry before applying nitrogen fertilizer. The fields are then reflooded, and observations indicate that nitrogen is taken to the rice roots as the water soaks into the soil. This results in more efficient use of the fertilizer.

Hall (*50*) described the water-seeding method used by some Arkansas growers. Seed is broadcast by plane into fields immediately after the application of 4 to 6 inches of water. The flood may be held for about 6 weeks before draining for the midseason application of nitrogen fertilizer. Other growers may drain their fields soon after the seed is sprouted and reflood after a few days. If fields are left drained for several days, heavy stands of grass weeds may become established. When rice is water seeded on heavy clay soils, this early draining is a common practice. The fields then are reflooded after about 3 days and the flood is maintained until midseason.

In a series of greenhouse experiments, Hall (*49*) found that unless rice plants were fertilized, the practice of draining and drying the soil and then reflooding did not increase grain production on soil low in organic matter.

Louisiana.—Jenkins and Jones (*62*) found that in date-of-submergence experiments in Louisiana, the highest average yields were obtained on land submerged 20 days after the seedlings had emerged. In a discontinuous and continuous submergence experiment, early continuous submergence (10 days after seedling emergence) of the land gave higher average yields than did intermittent drying of the land followed by continuous submergence.

In Louisiana, water seeding is not common; but where it is practiced, the water is drained when the rice seedlings are one-half inch long, according to Wasson and Walker (*145*). It then is allowed to grow until flooding is needed. Drilled rice may be flushed if necessary for uniform germination. Normally the rice is not flooded until it is 6 to 8 inches tall, and then only to a depth of 4½ inches. Fields are drained as necessary for topdressing with fertilizer and for pest control.

Mississippi.—Mullins (*89*) stated that rice in the delta area of Mississippi is kept flooded for 90 to 120 days during the growing season, depending on variety and seeding date. The first flood is applied as early as possible after the rice seed germinates and a stand is established. This may be about 2 weeks after seeding or, if germination is slow, possibly 3 weeks after seeding. Application of the first flood requires close attention to avoid breakage of levees and to stabilize the water at the desired level. If the levees are accurately located and well constructed, relatively little time is required to apply the first water; otherwise, labor requirements may be much higher. Mullins reported that most fields were drained after 3 to 4 weeks under flood and the soil was allowed to dry for several days. This permitted the roots of the rice plant to become more firmly established and also stimulated additional tillering. He suggested that if grass was well under control at this time, fertilizer could then be applied.

Texas.—Reynolds (*105*) stated that where rice is seeded with a grain drill on heavy soils, the fields usually are flushed (irrigated) for germination if water is available and if the soil has not been saturated by rain. Flushing usually is practiced in areas irrigated from canals, since the fields can be covered rapidly. Sandy soils and soils irrigated from wells usually are not flushed. After fields are flooded, irrigation water may be drained off once or twice during the growing season to permit fertilization and to control water weeds and insects. The time and number of drainings may vary, depending on the length of maturity of the variety, the presence of weeds and insects, and the supply of irrigation water. Where there is a shortage of water for reflooding, the fields usually are not drained. If irrigation is required to germinate the seed, the field is

promptly drained after this flushing. Where rice is seeded with an endgate seeder, the land is then harrowed and irrigated and the irrigation water is drained off shortly thereafter. It has been found from tests and general observations that satisfactory rice stands are not obtained if seeds are covered by both soil and water, so that draining water from fields where the seed is covered with soil is extremely important.

Morrison (*85*) found little difference in the rice yields at Beaumont when the total amount of water used ranged from 46 to 73 inches. He concluded that the use of 45 to 50 inches of water would be just as satisfactory as the use of larger amounts. These results generally agree with those reported by Jones and others (*69*). It was further concluded (*85*) that the depth of water does not seem to be of much importance where weeds are not a problem. Draining ricefields once during the growing season increased the yield of rice considerably.

Evatt (*31*) reported that preliminary tests conducted at the Rice-Pasture Research and Extension Center in 1956 and 1957 showed significantly reduced rough rice yields of the Century Patna 231 variety with use of deep water (10 to 12 inches), compared with use of average depths of water of from 4 to 6 inches from late tillering to maturity. He found that the temperature variation was 2 to 4° F. greater under the shallow water than under the deep water. Yields from superimposed fertilizer factorials showed no significant fertilizer-water depth interactions in 1956. However, in 1957 yields were less from both nitrogen and phosphorus treatments under the deeper water.

California.—In California where japonica-derived varieties predominate, ricefields normally are rapidly flooded to a depth of 6 to 8 inches just before seeding. Then they are seeded with presoaked seed immediately after flooding to enable the developing young rice plants to compete efficiently with soil organisms for available oxygen and with weeds for space and nutrients (*36*). The water is maintained at that depth until it is drained for harvest. Water may be lowered to about a 3-inch depth for weed control and at stand-establishment time during cool weather. If the soil in the field contains excessive amounts of salts, the water may become sufficiently saline as to be toxic to the rice seedlings. In such cases the water may be drained from the field and fresh water applied immediately. The continuous flood system comonly used in California was developed to control weeds, principally watergrass, and to fit the fertilizer requirements of rice (*38*, *83*).

Draining for Harvest

Draining at the proper time before harvest is necessary to dry the soil enough to support harvesting equipment. It is equally important to hold the water on the land long enough to permit the rice to reach proper maturity.

The time to drain depends on the type of soil, drainage facilities, and seasonal weather conditions. Some soils dry and crust quickly after drainage; others dry slowly. Less time is required to dry the soil early in the season when temperatures are higher and the days are longer than is required later in the fall. Growers soon familiarize themselves with the drying time of their soil, so that they can judge when to drain the fields to permit harvesting and yet not let the crop suffer for lack of soil moisture.

Usually the land may be drained when the rice is fully headed and the heads are turned down and are ripening in the upper parts. This stage ordinarily will be about 2 to 3 weeks before the crop is ready to cut. The date when the rice will be ready for harvest can be estimated by observing the date of first heading (when approximately one-tenth of the rice heads have emerged). Rice in the South normally requires 35 to 45 days from first heading to maturity. In California, crops of average yield will be ready for harvest about 45 days from the first heading. Heavy crops with yields of 5,000 pounds or more per acre may require as many as 55 days from first heading to maturity.

Water intake should be discontinued a few days before final drainage. The water already on the field will then recede slowly. This lessens lodging and does not overtax the drainage system with excessive water. In the South the field may be drained by removing the levee gate panels or by "cutting" the comparatively small levees with hand shovels. Levee gates sometimes are upended or may be removed from the fields before harvest. Dynamite is used quite extensively in California for opening levees to permit draining of ricefields before harvest. The levees are blown where they cross the drains that are installed within the fields. The dynamiting, which requires experienced powdermen, is started at the lower end of the field.

Harvesting, Drying, and Storing

Harvesting

Most rice grown in the United States now is directly harvested with self-propelled combines. It is then dried artifically before storing or milling. A small amount of seed rice is cut, swathed, and threshed from the windrow when the seed has dried down to 12 percent moisture or less. Direct combining and artificial drying is the most efficient and economical way of harvesting rice. Careful adjustment of the combine and proper drying methods result in grain having highest milling quality and commercial value.

Before adoption of direct combining, the United States rice industry used three other harvest methods, according to Smith (*124*). These, in order, were (1) harvesting by hand with a sickle or cradle, and then stationary threshing; (2) cutting with team-drawn or ultimately with tractor-drawn grain binders, handshocking the bundles, and then engine-powered stationary threshing; and (3) cutting with a tractor-drawn header or swather, followed by threshing from the windrow (when the grain was dry) with a pickup combine.

Direct combining was first tested in Arkansas and Texas in 1929 (*126*). According to Bainer (*13*), approximately 3,000 acres of rice were harvested by combines in 1929 in California, and nearly 35,000 acres in 1931. The combined harvester-thresher had been developed primarily for wheat, and the first models were not well suited to ricefield conditions. Low wet spots, weed patches, and high, narrow levees made combine harvesting difficult.

At the same time that combine harvesting was first being tried, tests were being conducted on artificial drying of rice (*126*). Even with the problems encountered in combining and artificial drying of rice, numerous advantages were cited. These included: (1) In one operation rice is removed from fields with no danger of weather damage; (2) very little loss of rice is sustained through shattering; (3) rice of high milling quality can be obtained regardless of weather conditions at harvest; and (4) all the rice can be thoroughly and uniformly dried, making it safe for storage either in bulk or in sacks. Also, it was pointed out that artificially dried rice usually is more uniform in quality because of the thorough mixing during the drying operations.

Additional advantages of the combine method over the binder, as pointed out by Slusher and Mullins (*121*) were (1) the elimination, to a large extent, of the need for outside labor for harvest; (2) less chance for loss from destructive wildlife, principally blackbirds and ducks; (3) possibility of salvaging a much higher percentage of crop in case of storm or wind damage; and (4) reportedly less field loss. These authors found that hand labor used in harvesting was reduced from slightly more than 11 hours per acre with the binder to from 2.4 to 3.6 hours with the combine method, depending on the size of the machine used. They reported that 400 acres of rice approaches the maximum seasonal acreage that a grower can safely plan on harvesting with one 12-foot self-propelled combine. Slusher (*120*) indicated that the usual crew for the self-propelled combine method consisted of one man on the combine, one man with a tractor and grain cart to haul grain from the combine to the truck, and two men and trucks to haul grain to the drier or elevator. One such crew usually could harvest about 16 acres of rice per 10-hour day.

Mullins (*89*) emphasized that the time required and the cost of harvesting depend largely on the weather at harvesttime. Heavy rains and wind often cause excessive lodging and create unfavorable surface conditions for operating combines and other equipment. Severely lodged rice may be harvested with combines that have adjustable pickup reels. When this is necessary, the combine must be operated at a much lower speed across a field, which greatly increases the time required for harvesting.

In a study of a large number of samples that included the effect of method of harvest on rice mill yield and grade, it was concluded that there was little difference between the combine method and the binder-thresher method of harvest as it related to the market value of the rice obtained.

Most rice now is handled in bulk (*122*), although some, especially that being saved for seed, still is sack dried. The conversion from sacking rice in the field to bulk handling was accentuated by increasing costs and scarcity of sacks and hand labor.

Today the self-propelled rice combine harvesters are equipped with relatively large bins or hoppers for collecting the threshed grain (fig. 37, *A*). The hoppers then are emptied by mechanically augering the rice into self-propelled "bankouts" or tractor-drawn carts that take the rice to waiting field-side trucks (fig. 37, *B*). Rice then is hauled to driers (figs. 37, *C* and 37, *D*) or to aeration bins (fig. 38) where it is unloaded by use of grain augers or other bulk-handling methods.

Hurst and Humphries (*61*) discussed harvesting of rice with combines and pointed out that care should be taken not to crowd the feed. Because rice straw is heavy and green at harvest, the ground speed of the machine should be slow enough to avoid clogging. Since the rice kernel is very susceptible to cracking, the cylinder should be run at a slower speed than for other cereal crops. Allowing a small percentage of kernels to crack may be necessary to thresh out a maximum yield.

Special self-propelled rice combines used in California are equipped with crawler tracks that enable the machine to cross wet spots, small ditches, and low levees. In rainy seasons, wide wooden mud cleats are bolted on to the tracks to increase the support for the harvester. Self-propelled combines used in the ricefields in the South usually are equipped with large tires with mud lugs so that they can be operated over the sloping levees.

In recent years, specially designed rice combines have been built by the major farm machinery manufacturers in the United States and are being used in the ricefields of the South and

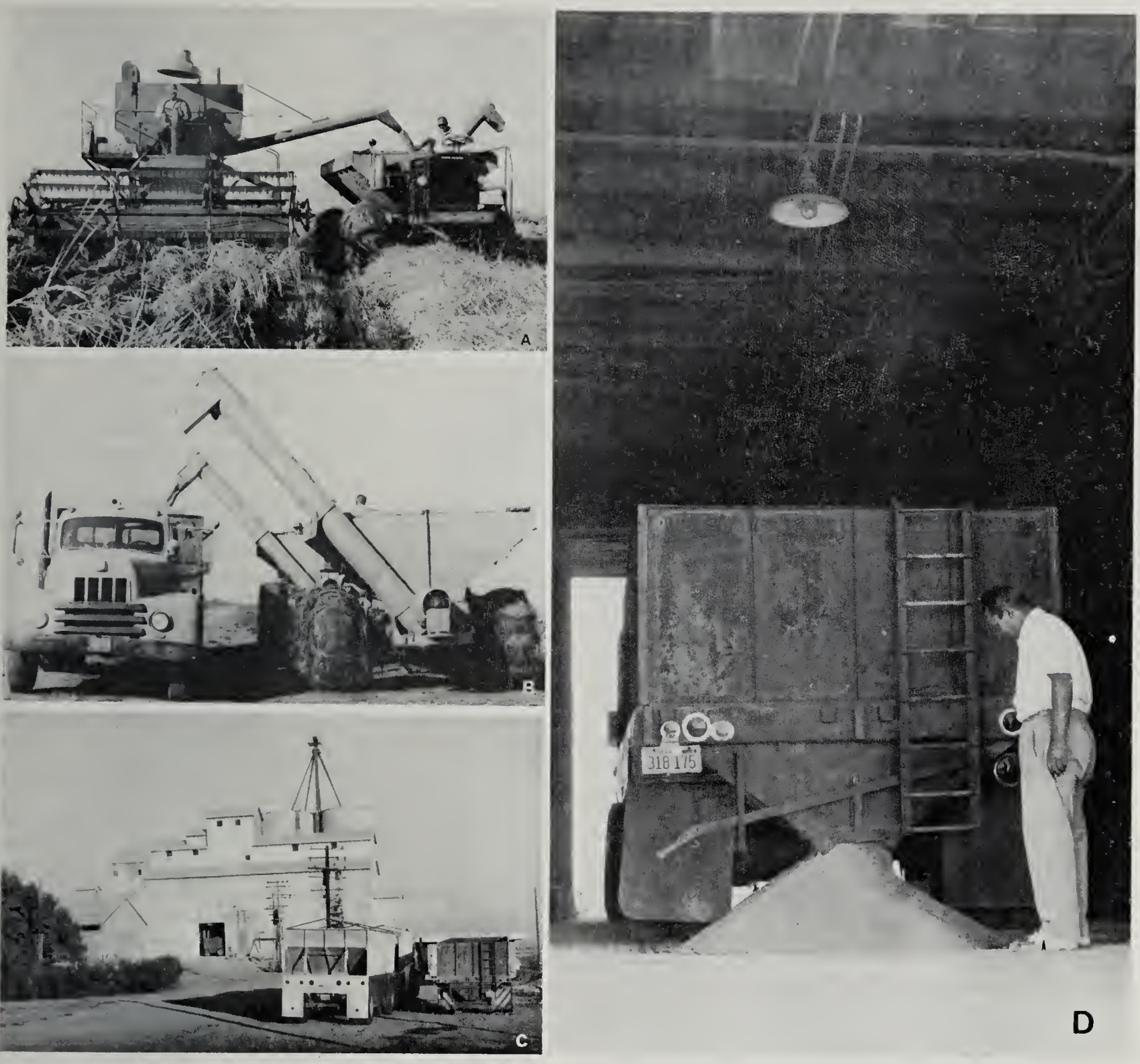

FIGURE 37.—*A*, Cutting and threshing rice with a combine harvester that is loading the rice into a "bank-out" or grain cart; *B*, transferring the rice from the "bank-out" into a truck in a road at field side; *C*, trucks loaded with rice waiting to unload at a farm drier; *D*, unloading the rice at the drier.

the West. These high-powered machines commonly have 12- to 16-foot headers and can be operated under extremely muddy conditions. They can be adjusted to do a thorough job of threshing with a minimum of shelling and cracking of the grain. Most combines now are equipped with straw choppers, which cut up the rice straw as it leaves the combine, and a distributor, which spreads the straw particles uniformly over the stubble to facilitate plowing under.

The effect of combine adjustment on harvest losses of rice was studied by McNeal (*79*). He found that there were four types of combine losses —cutter bar, cylinder, rack, and shoe. To obtain maximum grain yields, it was necessary for the cylinder bars and the concave to be in good condition and for the concaves and other parts of the combine to be properly adjusted. He concluded that combine ground speed should be reduced to one-half mile per hour when the rice is badly lodged. He indicated that the operator

FIGURE 38.—Bin drying combined rice on the farm.

is the most important factor in preventing high combine losses. The height at which the rice was cut was very important, since the proper amount of straw served as a cushion to the grain in the threshing process, and resulted in a lower cylinder loss and less hulling and breakage.

Curley and Goss (*22*) found that combine losses also may be due to overloading or improper machine adjustment or a combination of the two. Overloading as a result of excessive ground speed usually is the major cause for excessive loss in all sizes of combines.

Their tests in rice indicated that total combine loss including reel shattering should be less than 5 percent of the gross yield if the machine is properly adjusted and operated. Thus, the loss from a 6,000 pound per acre yield should not exceed 300 pounds. A high loss of unthreshed grain usually resulted from improper cylinder or concave adjustments, or from both. High loss of threshed seed came from poor separation in the straw walkers and cleaning shoe. They found that under California conditions reel shattering losses normally were insignificant in rice as compared with other small grains.

Curley and Goss suggest that several loss checks should be made on a machine in a given area to determine the effect of adjustment or change in ground speed. Detailed recommendations for machine and procedural adjustments for harvesting rice under California conditions also are listed by these workers.

MOISTURE CONTENT OF GRAIN AT HARVEST.—Smith and others (*127*) pointed out that rice must be of high milling quality to command a premium price, and that for this high quality and for maximum grain yields, rice must be cut at the proper stage of maturity. If the crop is harvested when immature, field yields usually are reduced and the breakage in combining and milling is excessive because of the light, chalky kernels. If the crop is left in the field until overripe, the kernels may check. This causes severe breakage during combining and milling and a reduction in the yield of head rice (whole kernels). Smith and others emphasized that when rice has reached the proper stage, harvesting should proceed rapidly, since loss of moisture in standing rice may be very rapid. In rice harvested at the proper stage, the grains were fully mature in the upper portions of the panicle and in the hard-dough stage at the base. Few, if any, chalky kernels were found in rice harvested at this stage of maturity. When such rice was properly dried, germination was satisfactory for seed purposes.

Bainer (*13*), Davis (*25*), Kester (*72*), McNeal (*80*), and Smith and others (*125*, *126*, *127*) have reported results of research relating stage of maturity (moisture content) of the grain to proper harvesttime. Although their findings varied, they were in general agreement that maximum yield of head rice was obtained when rice was harvested at a moisture content of about 18 to 24 percent and then immediately dried to between 13 and 14 percent.

Varieties differ in the range of harvesttime moisture content at which they yield the best quality milled rice. McNeal (*80*) reported that a range in moisture content of 16 to 22 percent provided the highest yield of head rice for Rexark and that a range of 17 to 23 percent provided the highest yield for Zenith. Davis (*25*) reported that the best range for Caloro was 20 to 25 percent, and Kester (*72*) and Kester and Pence (*73*) reported that the best range for Calrose was 22 to 27 percent. Their work showed that for every 1-percent reduction in kernel moisture while the unharvested grain was left in the field, the decline in head rice yield from the maximum was 1.4 percent for Caloro, 0.9 percent for Calrose, and 1.0 percent for Colusa.

Most ricegrowers determine the moisture content of hand-harvested samples of their rice before beginning harvest. Determinations usually are made with electrically operated moisture meters, which they own or which are available at the commercial driers.

Although kernel moisture content at harvesttime strongly influences rice quality and milling characters, environmental factors that affect the plant physiologically during the growing season also influence quality. Halick (*48*) has shown that a variety that ripened under lower temperatures (81° to 84° F.) produced higher head rice milling yields than did rice that ripened earlier in the season under higher temperatures (90° to 94°). Stansel, Halick, and Kramer (*134*) found that high temperatures (90° day and 80° night) increased chalkiness in all four varieties studied (Century Patna 231, Bluebonnet 50, Toro, and a glutinous variety). California rice quality

studies (*73*) showed that certain crop fertilization practices could result in declines in kernel characters such as weight, water uptake, hot-paste viscosity, and whiteness. Thus, when harvesting for maximum quality, many factors must be considered; but certainly moisture content of grain at harvesttime is among the most important.

Preharvest Chemical Drying.—Results from experiments with the preharvest application of chemical desiccants to speed the drying of rice in the field have been reported by Addicott and Lynch (*9*), Hinkle (*57*, *58*, *59*), Smith, Hinkle, and Williams (*123*), Tullis (*139*), and Williams (*147*). All materials were applied as sprays when the rice contained from 20 to 27 percent moisture. Materials tested at varying concentrations included (1) sodium chlorate-borate mixtures; (2) magnesium chlorate; (3) disodium 3,6-endoxohexahydrophthalate (alone and with ammonium sulfate); (4) sodium monochloroacetate; (5) S, S, S,-tributyl phosphorotrithioate; (6) sodium pentachlorophenate; (7) di-nitro-O-sec-butylphenal compounds (alone and in combination with aromatic oils); and (8) aromatic oils alone. Some of the chemicals studied by these investigators hastened the drying of rice in the field. However, none were entirely satisfactory because the milling quality was reduced, the kernels were discolored, or the chemical imparted an off-flavor to the rice.

Desiccants are used occasionally to hasten the drying of seed rice. However, no grower should use a desiccating chemical on his maturing rice crop until he has checked with his local agricultural authorities to determine its legal status with reference to chemical residue tolerances. Laws are strictly enforced in this regard, and an entire crop could be impounded if it exceeds the legally established chemical residue tolerances.

Drying and Storing

For the proper drying of rice, moisture must be removed from inside the kernel (*23*). If rice is dried too rapidly or if the temperature of the drying air is too high, quality is seriously impaired. To prevent internal checking or breaking of the kernels from drying too rapidly, drying usually is done in three to five stages. In each stage the rice passes through the drier and then is tempered in a bin, so that the kernel moisture will equilibrate.

Bainer (*13*) published one of the earliest accounts of artificial drying of combine-harvested rice. He concluded that rice could be dried successfully by artificial means but that the temperatures in the drier should not exceed 100° F.

Smith and others (*126*) reported on early research on artificial drying of rice in Arkansas and Texas. They concluded that a drying-air temperature of 120° F. could be used without injuring the rice if the moisture content was reduced only about 2 percent at each drying operation and the rice was allowed to remain in storage 12 to 24 hours between drying periods. However, when necessary to dry a given lot of rice in one operation, the drying-air temperature should not exceed 110°.

From experiments conducted with combined rice in 1944, 1945, and 1946, McNeal (*78*) concluded that in most cases the head rice yield was increased and the total drying time was decreased as the number of dryings was increased from one to four at temperatures ranging from 100° to 150° F.; and the tempering period between dryings was important, since it gave the moisture in the grain an opportunity to equalize and thereby reduced drying time. On the basis of more recent experiments, McNeal (*81*) concluded that the most desirable drying combination appeared to be four dryings at 120°.

In 1953, Aldred (*10*) summarized research on drying and storing rough rice in the Southern States. This summary covered work conducted by the Agricultural Experiment Stations in Arkansas, Louisiana, and Texas, and by the U.S. Department of Agriculture. This author gives information on volume of air used in column-type and bin-type driers; number of stages to use in drying rice; temperature of the air for drying; depth of rice when dried in bins; length of time rice can be held before drying; and the use of fumigants to protect rice from storage insects.

A comprehensive review of research in the United States on conditioning and storing rough and milled rice through 1958 (*23*) was published in 1959. This review cited 74 specific references and included participation by 36 contributors.

Types of Driers.—Driers can be classified by type as (1) continuous flow, including mixing and nonmixing; and (2) batch, including bins and potholes. Driers can also be classified as multi-pass and uni-pass. Multi-pass is a continuous-flow system; uni-pass is a batch system.

Wasserman and others (*142*) reported that mixing-type driers are of many designs. Two of the most popular mixing-type driers are the baffle design and the Louisiana State University (LSU) design (*1*). In the baffle design, rice is conducted downward in a zigzag path by means of baffles, while heated air is forced through the grain. In the LSU design of the baffle drier, layers of inverted-V-shaped air channels are installed in a bin with alternating air-inlet and air-exhaust channels. Each layer is offset, so that the tops of the inverted V's split the streams of grain as it flows down between the channels. Drying air passes from the air-inlet channels through the rice and out the air-exhaust channels (*142*).

Wasserman and others (*142*) stated that the

nonmixing columnar type drier is the simplest and most commonly used. In this drier, rice descends between two parallel screens set 4 to 6 inches apart while heated air is blown through the screens and intervening rice. No appreciable mixing occurs, and the effect is similar to drying in a static bed with a depth equal to the distance between the screens.

According to Morrison, Davis, and Sorenson (*86*), bin drying refers to drying grain in storage bins usually at depths of 6 to 8 feet. Normally the grain is dried in the same bin in which it is stored, which makes the method particularly suited to on-farm installations. In contrast, aeration is defined as the procedure used to cool and ventilate grain during storage to maintain quality. This is accomplished by turning the grain at frequent intervals, by transferring the grain from one bin to another, or by circulating air through the stored grain. Although drying may be accomplished with unheated (normal atmospheric) air under favorable conditions, a source of supplemental heat should be available during periods of high humidity.

Bin drying, consisting of drying with unheated air but supplemented with artificial heat, is used in on-farm installations, especially for seed rice. Supplemental heat refers to heat added to atmospheric air for limited temperature rise, usually less than 20° F., to accomplish drying within a maximum permissible time to prevent spoilage. Barr and others (*15*), Henderson (*53*, *54*, *55*), Hildreth and Sorenson (*56*), Sorenson (*129*, *130*), and Sorenson and Davis (*131*), all discuss the requirements for successful bin drying and its limitations.

Sorenson, Davis, and Hollingsworth (*132*) pointed out that some rice for seed is dried in pothole-type sack driers.

McNeal (*81*) describes two distinct procedures in use for commercial rice drying. These are the multi-pass system and the uni-pass system. In the multi-pass driers, air heated to approximately 120° F. is passed through a continuously moving column of rice in three or more passes. During the first pass a predetermined amount of moisture is removed; then the rice is stored for about 24 hours to allow the moisture to equilibrate throughout the individual kernels. As many additional passes are used as are necessary to reduce the moisture content of the rice to a safe storage level.

In uni-pass driers, air heated to 110° F. or higher is passed continuously through the column of rice in one operation until the moisture content of the grain is reduced to safe storage level. This system employs a pack 10 inches thick, and the direction of the heated drying air is reversed at regular intervals and the drying is accomplished in one pass.

Sources of Heat for Driers.—The amount of heat required for warming the air used by a rice drier depends on the initial temperature and moisture content of the air. The approximate quantity of heat required to raise the temperature of each 1,000 cubic feet of air and its moisture 1° F. is about 18.1 B.t.u.'s. To take care of initial air temperature, heat losses, and periods of above average humidity, results of experiments at Crowley, La., indicated that the heat source should provide 2 B.t.u.'s per minute for each cubic foot of air used. The most satisfactory source of heat was found to be natural or butane gas. It was pointed out that gas burners are relatively inexpensive and are easily regulated to maintain a desired air temperature. Also, since a clean flame is produced, the burner can be directed toward the inlet to the blower and the products of combustion allowed to pass through the drier (*1*).

Drying Rate and Temperature.—Unlike most cereals, rice is consumed primarily as unbroken kernels, so that the market value for whole kernels is much greater than that for broken kernels. Therefore, to avoid breaking the rice kernels, much more care is required in drying rice than in drying other cereals. The drying rate of rice depends on the rate of migration of moisture from the inside to the outside of the kernel. As the rice kernel is dried, the outer portion shrinks, setting up stresses and strains. When too much moisture is removed too rapidly, checking or shattering of the kernel results. To reduce this effect, rice is dried with air at 100° to 130° F. in two or more stages or passes through the drier. Between passes through the drier, the grain is held in a bin to allow the moisture to equilibrate throughout the individual kernels. This tempering relieves stresses and strains and facilitates drying in the next pass. Laboratory-scale studies with California-grown rice showed how drying-air temperature and number of passes through the drier affected head rice yield and total drying time. The relation of these factors has been represented on a single diagram to serve as an operating guide in the drying of rice (*142*).

Effects of High Temperatures on Seed Viability.—McFarlane, Hogan, and McLemore (*76*) studied the effects of heat treatment on the viability of rice. They also surveyed the literature involving rice and other grains. Germination tests confirmed that the effects of high temperatures on the viability of naturally moist rough rice were much the same as for other kinds of seed similarly treated. General observations included the following: (1) For a given sample of rice, the zone of heat damage (beginning of heat damage to loss of viability) is narrow; (2) the resistance of rough rice to impairment of its viability by heat varies inversely as its moisture content; and (3) when viability of rice is dam-

aged by heat, loss in germination vigor is apparent before loss in germination capacity.

In artificial drying experiments with seed rice, good results were obtained by continually rotating the seed from bin to drier to another bin until dry. An inlet air temperature of 120° F. and a 20-minute drying period were used. This method reduced drier capacity somewhat but eliminated the possibility of mold or fungus attacking the germ of warm, damp rice between drying periods (*1*). McNeal (*78*) showed that germination percentages were reduced when rice was dried at air temperatures above 130°.

Improving Efficiency of Commercial Driers.—Recent studies have shown how commercial drier capacity could be increased by about 50 percent and head rice yield by 2.5 percent without significant additional capital outlay or increased operating costs (*101*, *133*, *143*, *144*). Depending on the physical characters of the drying equipment, a combination of increased rate of flow through the driers (up to 50 percent) and higher drying temperatures (up to 150° F. for Caloro rice) is used to achieve increased drier efficiency. The findings are based on tests with rice varieties in southern areas as well as in California.

Calderwood and Hutchinson (*17*) conducted a series of experiments at Beaumont, Tex., to determine how best to hold freshly harvested rice until it could be dried. These studies, as well as those of Hutchinson and Willms (*60*), also included the use of unheated air to effect economies in rapidly cooling rice during the tempering periods between passes in the heated air column driers. Long-grain rice, with an initial moisture content below 20 percent, aerated with 0.43 cubic feet per minute per 100 pounds, showed no change in grade when held in temporary aerated storage for 10 days before drying. Medium-grain Gulfrose, with an initial moisture content of 23 percent, aerated with 0.43 cubic feet per minute per 100 pounds, was not damaged when stored for 3 days. Another lot, with an initial moisture content of 22 percent, aerated with 1.24 cubic feet per minute per 100 pounds for 7 days before drying, showed a sharp drop in grade.

Infrared Drying of Rough Rice.—As long ago as the early 1940's, Texas and California rice-growers experimented with industrial infrared lights as a heat source for drying rice. By 1948 California workers had reached the conclusion that infrared rice drying was no faster than convection-type driers, and was not as efficient.[5] In their six experiments, 7,300 B.t.u.'s were required to remove 1 pound of water from rice, whereas convection-type sack rice driers then in use were using 2,000 B.t.u.'s.

[5] Unpublished reports from the University of California, Department of Agricultural Engineering.

Infrared drying of rice has not yet become established commercially but interest continues. Schroeder (*109*, *110*) and Schroeder and Rosberg (*111*, *112*) reported on laboratory rice-drying experiments. Varieties apparently respond differently. The drying rate for the 15-, 20-, and 25-second irradiation periods ranged from 1.2 to 1.9 grams of water removed per second of irradiation for Nato and from 1.3 to 1.6 grams for Magnolia. Tilton and Schroeder (*138*) found that rice weevils and lesser grain borers in rough rice could be controlled by irradiation with infrared lights. They postulated that using gas-fired infrared heating for drying rough rice would have the additional benefit of killing all stages of these stored-rice insects during the rice-drying process.

In utilizing on-farm bin drying and storing, the rice farmer is assuming considerable responsibility for items that he pays someone else to assume when he employs commercial facilities. These include (1) considerable supervision over a long period of time to oversee the drying, particularly if he uses unheated air; (2) greater chance of rice deterioration; (3) protection of the rice from insect, bird, and animal pests; and (4) protection against rain or flood damage. Offsetting these are usually lower cash outlays per unit volume of rice dried and stored.

Dachtler (*23*) emphasized that the use of the proper airflow rate to dry rice with unheated air is of primary concern in bin drying rice. Air must be supplied at a rate to complete drying before the rice is damaged by mold growth or other causes. Recommendations developed from tests in the Southern States and in California are summarized by Dachtler (*23*). Supplemental heat is not recommended as a standard practice for bin drying. However, it is desirable to have the necessary equipment available for use during prolonged periods of adverse weather. This normally will include extended periods of high humidity (above 75 percent). The temperature of the air entering the rice may be raised 10° to 15° F. above the ambient temperature. A maximum of 95° is recommended in Texas, and a maximum of 80° to 85° in California. Supplemental heat should be used until the moisture content of the top foot of rice is reduced to 15 percent. After the moisture is reduced to this level, unheated air should be used to complete the drying to a safe storage level. During the time unheated air is used, the fan should be operated only when the relative humidity is less than 75 percent, which usually will be during daylight hours on clear, bright days.

Aerating Stored Rice.—According to Hutchinson and Willms (*60*), the practice of aerating grain came into widespread use in the Southwest between 1955 and 1960. They indicate aeration is used (1) to maintain the quality of undried

grain until it can be moved through the drier, (2) to remove harvest or drier heat, (3) to remove small amounts of moisture (1 to 2 percent), and (4) to maintain the quality of grain during storage. Aeration is defined as the moving of air through stored grain at low airflow rates (generally between one-tenth and one-fifth cubic feet per minute per 100 pounds) for purposes other than drying, to maintain or improve its value. Several types of aeration systems are described, as are methods of operation and controls.

Aldred (*10*) presented the following conclusions regarding storage and aeration of rice:

(1) Based on information to date (1952), rice in bulk storage should be turned once every 2 months during the winter and at least once a month during the summer.

(2) With proper aeration, rice with a moisture content of 18 to 24 percent can be kept for a week or 10 days without spoilage.

(3) For retaining rice with a moisture content of 18 to 24 percent before drying, 2 cubic feet per minute per 100 pounds is adequate. After the rice has been partly dried, one-half cubic foot per minute per 100 pounds is adequate.

(4) Rice with a moisture content below 16 percent can be kept several months in either cool or warm weather with the aid of aeration.

As pointed out by Dachtler (*23*), practically all rough rice is stored in bulk, although sack storage is practical for relatively small lots and for seed rice. A maximum moisture content of 12 percent is recommended for seed rice, but up to 14 percent usually is safe in bulk storage. The length of the storage period for rice depends on market conditions, but it usually is from 5 to 8 months. For any common-type storage bin, any type of construction material is satisfactory if it results in a storage structure that will keep the grain dry, cool, and free of insects and other pests and if it provides job safety and convenience while moving and inspecting the grain. Dachtler warned that if dried rough rice is to be stored for a few months or longer or if damp rice is to be held before drying, the storage structure should be equipped for aeration.

Insect Infestation of Stored Rice.—Insect infestation generally occurs after rice is in storage, since most rice harvested and dried by modern methods is relatively free of insects upon entering storage (*23*). Insect control practices that are used before and during storage have been developed through research and are widely applied. Emphasis now is being placed on the use of protective treatment. Chemicals are now available that can be mixed with or sprayed on the rice as it is stored and that will protect it against invading insects yet leave no residues harmful to human beings (*108*, *140*). For information about the use of these chemicals, contact your local agricultural authorities.

Stored rice is subject to attack by a number of insects. The lesser grain borer (*Rhyzopertha dominica* (F.)), the Angoumois grain moth (*Sitotroga cerealella* (Oliv.)), and the rice weevil (*Sitophilus oryzae* (L.)) attack sound rough rice kernels. The cadelle (*Tenebroides mauritanicus* (L.)), the saw-toothed grain beetle (*Oryzaephilus surinamensis* (L.)), the flat grain beetle (*Cryptolestes pusillus* (Schon.)), the red flour beetle (*Tribolium castaneum* (Herbst)), and the confused flour beetle (*T. confusum* (Duv.)) attack broken or dehulled kernels. Moths that infest the surface of bulk or bagged rough rice and spin webbing in profusion include the Indian-meal moth (*Plodia interpunctella* (Hbn.)), the almond moth (*Ephestia cautella* (Wlkr.)), and the rice moth (*Corcyra cephalonica* (Staint.)). In storing bran and milled rice, control of the bran bugs, including the flour beetles, is important (*108*, *140*).

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CAUTION.—If pesticides are handled or applied improperly, or if unused parts are disposed of improperly, they may be injurious to humans, domestic animals, desirable plants, pollinating insects, fish or other wildlife, and may contaminate water supplies. Use pesticides only when needed and handle them with care. Follow the directions and heed all precautions on the container label.

WEEDS AND THEIR CONTROL

By R. J. Smith, Jr., and W. C. Shaw

Losses in the rice crop due to weed competition amount to more than $60 million each year. In addition, farmers spend almost $24 million each year to control weeds. Among the weeds that cause severe losses in rice are barnyardgrass (*Echinochloa* spp.), red rice (*Oryza sativa* L.), signalgrass (*Brachiaria* spp.), sprangletop (*Leptochloa* spp.), sesbania (*Sesbania exaltata* (Raf.) Cory), curly indigo (*Aeschynomene virginica* (L.) B.S.P.), Mexican-weed (*Caperonia castaneaefolia* (L.) St. Hil.), gooseweed (*Sphenoclea zeylanica* Gaertn.), redstem (*Ammannia coccinea* Rottb.), ducksalad (*Heteranthera* spp.), bulrush (*Scirpus* spp.), umbrellasedge (*Cyperus* spp.), spikerush (*Eleocharis* spp.), and various species of algae.

Conditions favorable for growth of rice also are favorable for growth of these weeds. Weeds in rice produce an abundance of viable seeds; and once weeds infest the soil, they are difficult to remove. The best approach to weed control is to prevent weed infestations by seeding weed-free rice and by removing scattered weed seedlings from the field before they produce seed. Even after weeds infest the soil, however, they can be effectively controlled by selected cultural and chemical methods.

Weed control is the primary aim of many cultural practices. Herbicides—notably propanil and the phenoxy herbicides—have been used in conjunction with good farming practices for controlling weeds and have greatly increased the effectiveness of the cultural practices. As chemical methods of weed control change—and they are changing rapidly—cultural practices also will change.

Certain young grass and broadleaf weeds in rice were effectively controlled in 1959 by propanil [3,4-dichloropropionanilide]. Propanil is very selective, and rice is not injured by high rates applied soon after emergence. In 1961 rice farmers in the major ricegrowing States used propanil as a postemergence weed killer in commercial fields on about 20,000 acres. Because propanil controlled grass weeds so effectively in 1961, and because it was recommended by the agricultural experiment stations in Arkansas, Mississippi, and Texas, rice farmers treated approximately 250,000 acres in 1962. Overall, good-to-excellent grass and weed control and significant improvement in rice yields were obtained in more than 90 percent of the fields treated in 1962.

Propanil controls barnyardgrass, including the species *Echinochloa crusgalli* (L.) Beauv., *E. colonum* (L.) Link, and E. *cruspavonis* (H.B.K.) Schult.; and other grasses, including crabgrass (*Digitaria* spp.), Texas-millet (*Panicum texanum* Buckl.), paragrass (*P. purpurascens* Raddi), and signalgrass (*Brachiaria* spp.). Propanil also controls certain young annual broadleaf weeds including sesbania, curly indigo, gooseweed, and redstem; and young annual sedges, including spikerush, umbrellasedge, and *Fimbristylis* spp. Propanil controls all these weeds most effectively when they are in the early vegetative stage of growth.

Propanil kills the cells of grass-weed and broadleaf-weed plants by contact action. It is usually applied when both the weeds and the rice are in the early stages of development. Barnyardgrass and other grass weeds are controlled most effectively when propanil is applied in the 2- to 3-leaf stage, or when the grass is 2 to 3 inches tall. However, rapidly growing grass weeds in highly fertile soil and deep water may be controlled satisfactorily when the grass weeds have four or more leaves.

Propanil should be applied according to the developmental stage of the grass weed rather than that of the rice. However, a reasonably heavy stand of rice should be growing before treatment; otherwise if replanting is necessary, the effectiveness of the herbicide is lost.

Irrigation stimulates the growth of grass weeds and makes them more susceptible to propanil, but water should not be standing on fields when propanil is applied because propanil cannot reach weeds covered with water. Fields treated with propanil should be flooded 1 to 4 days after treatment to increase the activity of the herbicide on barnyardgrass and to prevent barnyardgrass and other grass-weed plants from reinfesting the field.

Propanil may be applied with either ground or aerial equipment. Aerial equipment has the advantage because fields may be sprayed when the soil is too wet to support ground equipment, and also levees do not present a problem as with ground equipment. The spray solution of propanil should cover the weeds adequately and uniformly but should not be allowed to drift onto nearby areas where it can injure field crops such

as cotton and soybeans and certain horticultural and ornamental plants. Young cotton and soybean plants are susceptible to propanil until they are 8 to 10 inches tall and can be killed or injured severely enough to reduce yields greatly.

Postemergence treatments with phenoxy herbicides control most broadleaf and aquatic weeds and many sedges that infest rice. Grass weeds are not controlled. Phenoxy herbicides are often used by commercial ricegrowers, and more than half of the rice crop in the United States is sprayed each year for broadleaf-weed control.

Phenoxy herbicides used for controlling broadleaf weeds in rice include 2,4–D [2,4-dichlorophenoxyacetic acid], MCPA [2-methyl-4-chlorophenoxyacetic acid], 2,4,5–T [2,4,5-trichlorophenoxyacetic acid], and silvex [2-(2,4,5-trichlorophenoxy)propionic acid]. These herbicides are applied as either amine salt or low-volatile ester formulations at rates of ½ to 1½ pounds per acre acid equivalent. The rate depends on the weed species and the stage of growth of the rice.

Response of rice to phenoxy herbicides is affected chiefly by the stage of development of the rice plant. Very young rice is injured severely or even killed by 2,4–D, MCPA, 2,4,5–T, and silvex. Rice in late-jointing, booting, or heading stages may be injured severely. Rice in the late-tillering or prejointing stages is usually uninjured by phenoxy herbicides. Rice responds differently to these various postemergence herbicides. It is most "tolerant" to 2,4,5–T, less "tolerant" to silvex and MCPA, and least "tolerant" to 2,4–D.

Weeds also respond differently to 2,4–D, MCPA, 2,4,5–T, and silvex. When several species varying in susceptibility to a herbicide are present in one ricefield, mixtures of phenoxy herbicides may be used advantageously. Weeds are usually most susceptible to phenoxy herbicides when they are young and growing rapidly. Therefore, it is important to treat weeds as soon as the rice is adequately "tolerant" to the herbicide—usually about 7 weeks after rice emerges.

Water management affects the response of weeds to phenoxy herbicides. Herbicides are less effective in reaching weed plants that are covered by water, and herbicides cannot effectively control weeds that are growing slowly because of dry soil. Therefore, herbicides should be applied soon after draining, while weeds are growing rapidly. If the field is flooded too soon after spraying or if rain falls immediately after spraying, the herbicide is washed off the weed plants and cannot control their growth.

Phenoxy herbicides are sprayed uniformly to the field with low-gallonage sprayers attached to ground or aerial equipment. Care must be taken not to injure other crops such as cotton, soybeans, and tomatoes and valuable trees, shrubs, and ornamental plants. All major rice-producing States strictly regulate aerial applications of phenoxy herbicides. Most States regulate ground applications. These laws prohibit the use of high-volatile esters of 2,4–D, MCPA, 2,4,5–T, and silvex. Definite regulations as to equipment, herbicide formulations, wind velocity, records, responsibility, and liability must be observed. Before spraying rice with postemergence herbicides, farmers and custom applicators should become familiar with State laws so they can comply with them.

CAUTION.—Before being used for applying insecticide or fungicide, spray equipment that has been used for applying 2,4-D, 2,4,5-T, MCPA, or silvex should be given a special cleansing with ammonia or with activated charcoal and detergent. For detailed instructions, consult your State extension weed specialist.

Certain algae may be controlled with applications of small copper sulfate crystals applied in the early stages of scum development. Differences in the species of algae and in local water and soil conditions determine the amount of control possible. Copper may be toxic to fish, so care must be taken if water from treated ricefields is collected in reservoirs containing fish.

RICE DISEASES

By J. G. Atkins

Rice diseases are economically important in the rice crop in the southern rice area (*3*).[1] Except for seedling disorders, these diseases are of no importance in California. Annual losses in Louisiana and Texas average about 8 percent. Diseases are important in rice, but they are not as disastrous in rice as in many other crops. Although average losses in most fields are rather low, losses in individual fields from specific diseases are sometimes high.

Most of the world's important rice diseases are known to occur in the United States. Exceptions are the rice dwarf and rice stripe viruses, bacterial leaf blight, and certain physiological disturbances reported from Japan and other Asiatic countries. A few minor diseases caused by fungi are also not known to occur in the United States.

The severity of specific diseases is influenced by varietal susceptibility, fertilization, soil type, and environmental conditions. Losses from certain diseases can be reduced or held to a low level by the use of resistant varieties, better cultural and management practices, and seed treatment. Diseases shift in prevalence and severity with changes in varieties. The reaction of 18 rice varieties to some diseases in the United States are shown in table 19.

Table 19.—*Reaction of rice varieties to some diseases of rice in the United States*

[R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; VS = very susceptible]

Grain type and variety	Blast	Brown leaf spot	Narrow brown leaf spot	Straighthead	White tip	Hoja blanca
Short-grain:						
Caloro	S	S	S	S	S	S
Cody	S	S	S	S	S	S
Colusa	S	MS	S	S	S	R
Medium-grain:						
Arkrose	S	S	S	S	VS	R
Calrose	VS	MS	MS	S	VS	S
Gulfrose	R, S	MS	R	S	S	R
Magnolia	S	MS	S	S	S	S
Nato	S	MS	MS	MS	S	S
Northrose	S	S	S	MR	S	MR
Zenith	R, S	MS	S	S	S	S
Long-grain:						
Belle Patna	S	S	S	R	R	S
Bluebonnet 50	MS	S	S	R	R	S
Century Patna 231	S	S	MS	VS	R	S
Rexoro	S	S	VS	VS	R	S
Sunbonnet	MS	S	S	VS	R	S
Texas Patna	S	S	VS	R	R	S
Toro	S	S	MS	R	R	S
TP 49	S	S	MS	VS	R	S

Major Diseases

Blast

Blast, caused by the fungus *Piricularia oryzae* Cav., occurs in all ricegrowing areas of the world and is the most damaging disease of rice (fig. 39). Blast in the United States is about as old as the rice crop itself—it caused trouble shortly after rice was introduced into South Carolina (*22*) and then into Louisiana (*18*). Losses from blast were light from about 1935 to 1955; however, in the southern rice area, particularly Louisiana, seriously infested fields have been found each year since 1955 (*9*). Blast has been one of the chief factors in preventing successful rice culture in southern Florida.

When the fungus attacks the leaves, the disease results in leaf blast. Symptoms are elongated or spindle-shaped leaf spots with grayish

[1] Italic numbers in parentheses refer to Selected References, p. 120.

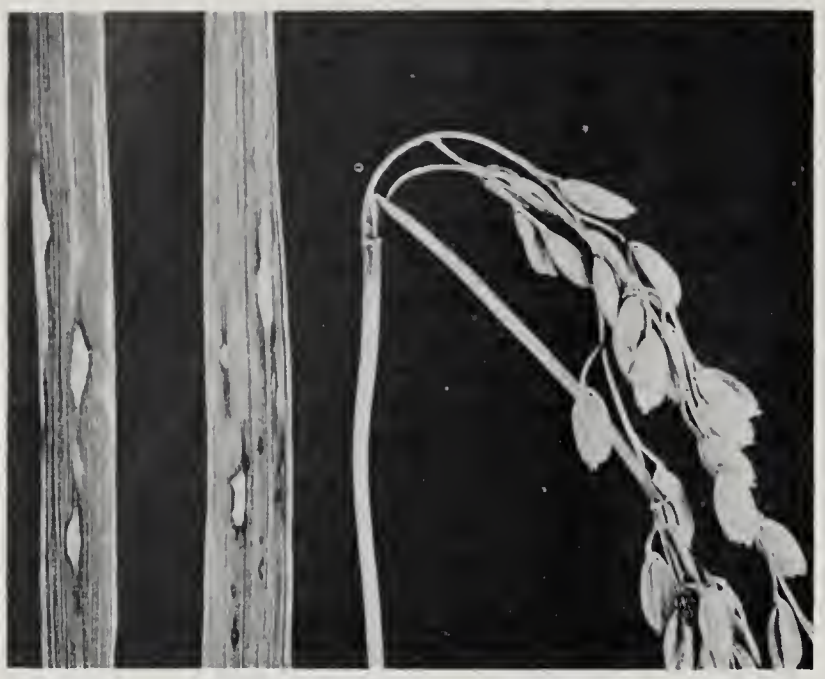

FIGURE 39.—The long, narrow spots on the leaves and the infection at the base of the panicle, which caused it to break over, are typical symptoms of blast. (Photo courtesy of G. E. Templeton.)

centers and brown margins. Under severe disease conditions, nearly all leaves are killed and many young plants are killed or severely damaged. Young plants are also killed by infection of the sheath tissues, which turn brown. Generally, all plants in a ricefield are not uniformly affected. In some areas the plants are killed, but in others they are affected less severely. The leaves are susceptible from the seedling through the early-tillering stage of growth. Under flooded soil conditions, the leaves are less susceptible in the late-tillering stage of growth and at heading. As a result, severely diseased fields of young rice appear to recover later when the plants become older and progress through the vegetative growth stages.

Head blast, also called rotten neck, results from the attack of the fungus after emergence of the panicle (head) from the boot or top leaf sheath. The peduncle (the top node and internode) and the branches of the panicle are very susceptible to attack. Typically, the peduncle shows a necrotic, brown area that prevents movement of food into the developing grain. The grain produced in affected panicles varies from nearly normal amounts to none, depending on the time of infection in relation to flowering. As infection weakens the structural tissues of the peduncle, the panicles frequently break over to give the condition known as rotten neck.

Atmospheric moisture conditions are of primary importance in infection and spread of the fungus that causes blast (*19*). Frequent rains, heavy nightly dews, and high relative humidities favor disease development. Severe outbreaks of the disease occur after periods of rainy weather.

Rice plants under high levels of nitrogen fertilization are susceptible to blast. Plants growing under nonflooded or upland conditions are more susceptible than those growing under flooded or irrigated conditions (*19*). For this reason, blast is often heavier on the levees and on or around knolls or other high areas in the ricefield than it is on the low areas.

All United States rice varieties are susceptible to one or more of the 10 pathogenic races of *P. oryzae* known to occur in the southern rice area (*4, 20*). However, Rexoro, Texas Patna, and TP 49 usually escape infection because they are late maturing. Under average field conditions, Bluebonnet 50 and Sunbonnet are less severely infected than are several other varieties, and losses are lighter. Arkrose, Caloro, Calrose, Colusa, Nato, and Northrose are consistently susceptible. Gulfrose and Zenith are resistant to most races. The reaction of 18 varieties to 10 races is given in table 20.

Brown Leaf Spot

Brown leaf spot of rice is caused by *Helminthosporium oryzae* B. de Haan, the same fungus that causes seedling blight. The spots occur chiefly on the leaves but are frequently on the hulls (fig. 40). The leaf spots are oval to circular and grayish brown to black.

Brown leaf spot is prevalent in the southern rice area. Under good cultural conditions, damage is slight on vigorous plants. Weak plants with yellowish leaves, caused by low nitrogen levels, root damage, or other factors unfavorable for good nitrogen nutrition, are often severely damaged by brown leaf spot.

All commercial rice varieties are susceptible to brown leaf spot. Bluebonnet 50 is generally more susceptible than are most other varieties. Management and fertilizer practices that promote good growth reduce losses.

Narrow Brown Leaf Spot

Narrow brown leaf spot in rice, caused by the fungus *Cercospora oryzae* I. Miyake, is one of the most prevalent rice diseases in the southern rice area. The leaf spots are narrow or linear and light to dark brown (fig. 41). When severe, the leaves die, one after another, beginning with the lower leaves. In most seasons, infection does not become severe until late August or September. Early-maturing rice varieties, when sown early, tend to escape heavy infection.

Rice varieties show marked differences in susceptibility. Several pathogenic races or strains of *C. oryzae* occur in the United States (*23*). Bluebonnet 50, Rexoro, and Texas Patna are susceptible varieties. Under average field conditions, Century Patna 231, Gulfrose, Nato, Toro, and TP 49 are fairly resistant.

TABLE 20.—*Reaction of rice varieties to the races of* Piricularia oryzae *Cav. in the United States*
[R = resistant; MR = moderately resistant; S = susceptible]

Grain type and variety	Race									
	1	2	3	4	5	6	7	8	10	16
Short-grain:										
Caloro	R	S	S	S	R	S	S	S	R	S
Cody	R	MR	S	S	R	S	S	S	R	-------
Colusa	R	S	S	S	R	S	S	S	R	-------
Medium-grain:										
Arkrose	R	S	S	S	R	S	S	S	R	S
Calrose	R	S	S	S	R	S	S	S	R	-------
Gulfrose	S	R	R	R	R	R	S	R	R	R
Magnolia	R	R	S	R	R	S	S	R	R	S
Nato	R	R	S	R	R	S	S	R	R	S
Northrose	R	S	S	S	R	S	S	R	R	S
Zenith	S	R	R	R	R	R	S	R	R	R
Long-grain:										
Belle Patna	S	R	S	R	R	S	S	S	R	R
Bluebonnet 50	S	R	S	R	R	S	S	R	R	S
Century Patna 231	S	R	S	R	R	S	MR	R	R	R
Rexoro	S	R	S	R	R	S	S	S	R	R
Sunbonnet	S	R	S	R	R	S	S	S	R	-------
Texas Patna	S	R	S	R	R	S	S	S	R	R
Toro	S	R	S	R	R	S	S	S	R	S
TP 49	S	R	S	R	R	S	S	S	R	R

FIGURE 40.—Oval to circular lesions on rice leaves are symptoms of brown leaf spot.

FIGURE 41.—Linear lesions on rice leaves are symptoms of narrow brown leaf spot.

Root Rot

Root rot of rice is a general diseased condition in which the roots grow poorly, darken with necrosis, or die. As decay progresses, the leaves cease to grow normally and turn yellow. Affected plants generally show heavy brown leaf

spot because of their impaired physiological condition.

Several soil fungi may cause root rot. Damage is more severe when nematodes and root maggots feed on the roots. Plants growing in saline soil and alkali spots in fields are also affected.

Losses from root disorders can be held to a minimum through good cultural and fertilizing practices that maintain the plants in a vigorous condition. Draining the field and permitting the soil to dry stimulates growth of new roots. For many years growers have used this practice to control root maggots and straighthead in conjunction with topdressing applications of nitrogen.

Seedling Blight

Fungi in the soil and on or in the seed cause seedling blight of rice (fig. 42). These fungi reduce emergence and kill or weaken the plant after emergence. Low soil temperature and high soil moisture, combined with seedborne fungi, or combinations of the two, make stand establishment difficult.

Satisfactory stands are generally obtained through use of good-quality seed treated with a fungicide and seeded under conditions favorable for rapid emergence. Atkins, Cralley, and Chilton (*7*) reported that thiram, chloranil, dichlone, and a number of organic mercurys gave best results. Seedling blight caused by *Helminthosporium oryzae*—the fungus that causes brown leaf spot—can be partly controlled by using one of the mercury fungicides. Each of the chemicals listed is available in different preparations.

WARNING

The materials recommended here for treating rice seed should be considered poisonous to man and animals. Care should be taken in handling and using them. Read the label placed on each container by the manufacturer and follow his instructions regarding safety measures. All workmen operating seed-treating equipment should be carefully taught how to use the chemicals and should be warned against carelessness. Sacks of treated seed should always be properly labeled. Care should be taken to prevent any treated seed from being used as food or feed.

Stem Rot

The stem rot fungus *Leptosphaeria salvinii* Catt. (*Sclerotium oryzae* Catt.) lives in the soil as sclerotia from one season to another up to 6 years (*30*) (fig. 43). Typically, rice plants are attacked in the advanced-growth stages. Initially, the fungus invades the sheath tissues near the water level and produces dark areas. The

FIGURE 42.—Three blighted rice seedlings and, at right, a healthy seedling.

FIGURE 43.—Rice culms showing sclerotia of the stem rot fungus. (Photo courtesy of G. E. Templeton.)

fungus progresses inward to the culm. The nodes and internodes turn dark and weaken. Many of the plants lodge because of rotten culms. The plants are weakened or killed before maturity. Little grain is produced and its quality is reduced.

None of the rice varieties are highly resistant to stem rot (*14*). Rexoro is perhaps the most susceptible variety. Some of the medium-grain varieties are resistant or intermediate in reaction. The early-maturing varieties tend to escape severe damage if seeded early. High rates of nitrogen fertilizer increase the susceptibility of plants to stem rot damage, but potassium fertilizers reduce damage.

Straighthead

Straighthead, sometimes called blight, is a nonparasitic or physiological disease of rice. Diagnostic symptoms are observed only in the panicles. The panicles remain upright at maturity because of lack of grain development (fig. 44); hence, the common name of straighthead. The shape of the palea and lemma, which later form the hulls, is distorted, particuarly in the long-grain varieties. It is similar to a parrot beak, crescent, or half moon. Hull distortion may or may not be conspicuous in the short- and medium-grain varieties.

Straighthead is caused by unknown soil conditions associated with prolonged submergence of the soil with water. Undecayed organic material and arsenic in the soil are also factors. In general, rice grown on the lighter or sandy soils is more subject to straighthead than rice grown on the heavier clay soils.

For many years, ricegrowers have followed the practice of draining and drying the soil to prevent straighthead (*27*). The fields are drained, dried, and reflooded just before panicle formation. This period is about 50 days after seedling emergence for Century Patna 231, a susceptible, early-maturing variety (*13*). However, the best control measure is to use resistant varieties.

The numerous rice varieties have been classified as to straighthead reaction (*6*). Belle Patna, Bluebonnet 50, Lacrosse, Texas Patna, and Toro are resistant. Nato is intermediate in reaction and is seldom affected.

White Tip

White tip of rice is caused by an ectoparasitic, foliar nematode, *Aphelenchoides besseyi* Christie (fig. 45). The nematodes are seedborne and live from one crop to the next in the seed rice. After rice is sown, the nematodes become active and move into the growing point of the young rice plants. In this protected location, the nematodes feed and reproduce. The feeding by large numbers of nematodes injures the developing leaves and panicles before emergence. The injury is later observed as white, necrotic leaf tips and small, usually sterile panicles. Grain yields in susceptible plants are greatly reduced.

Several methods may be used to control white

FIGURE 44.—Erect panicles with sterile florets are typical of rice plants affected with straighthead.

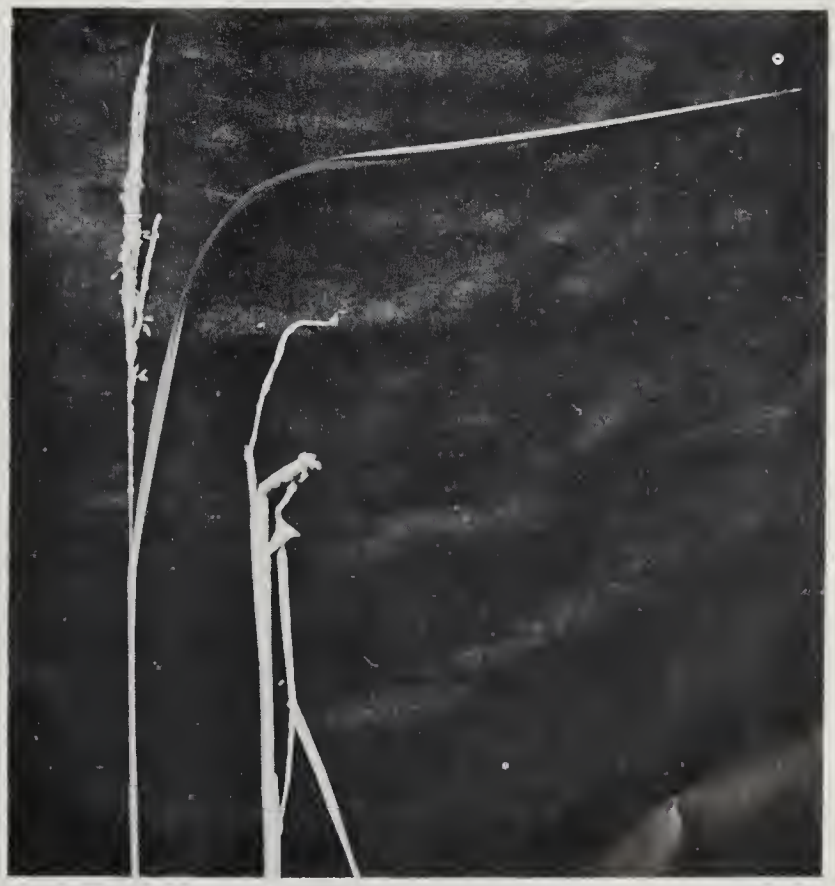

FIGURE 45.—*Left*, healthy rice panicle; *right*, panicle affected with white tip.

tip. Resistant varieties or nematode-free seed may be sown. Cralley (*15*) and Todd and Atkins (*28*) have described hot-water treatments that control white tip very effectively. They are not practical for general use. However, they can be used by the rice experiment stations for treating small lots of base seed used in foundation seed programs. Emergence through water following water seeding controls white tip (*16*). This practice can also be used to clean up small lots for seed production.

Several rice varieties are resistant to white tip (table 1). In general, the long-grain varieties are resistant and most of the short- and medium-grain varieties are susceptible (*12*). Although white tip was an economically important disease in the southern rice area for many years, it is no longer important.

Minor Diseases

Bordered Sheath Spot

Bordered sheath spot in rice is caused by *Rhizoctonia oryzae* Ryker & Gooch. The sheath spots are large, 2 to 6 centimeters long, and frequently encircle the sheath. The margins of the spots are reddish brown. During wet weather, the leaves of rice plants in small areas, 2 to 6 feet in diameter, are killed by *Rhizoctonia* spp.

Hoja Blanca

Hoja blanca, or white leaf, is a virus disease of rice that is transmitted by a planthopper, *Sogata orizicola* Muir. Leaf symptoms are one or more white stripes along the leaf blade or a whitening of the entire leaf blade (fig. 46). Diseased plants are generally reduced in height. The panicles are reduced in size and often fail to emerge completely from the boot. The palea and lemma are generally distorted in shape and later turn brown. Most florets are sterile. Since the diseased plants produce few, if any, seed, the panicles remain upright instead of bending over like those of normal plants (fig. 47).

Hoja blanca occurs only in the Western Hemisphere. Leaf symptoms are similar to those of the stripe virus disease of Japan, but the two diseases differ (*8*). Hoja blanca was first recognized as a new rice disease in 1956 (*2*). Severe yield losses were reported from Cuba, Venezuela, and other countries of Latin America. The disease and insect vector were found in 1957 in Florida (*5*), in 1958 in southern Mississippi (*10*), and in 1959 in Louisiana (*11*). An eradication program was initiated after each finding of the insect vector. In 1960 and 1961, neither the disease nor the insect vector was found in the southern rice States. In 1962, *S. orizicola* was again found and collected in southern Louisiana (*1*).

Yield losses from hoja blanca in the United States have been negligible. Unless the disease and insect vector become established and cause economic losses, no control measures need be con-

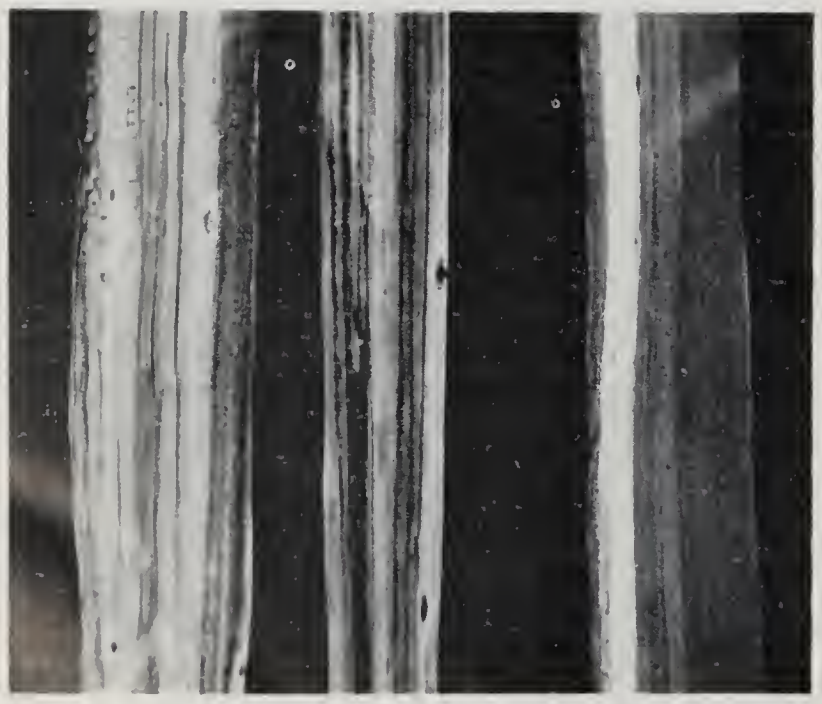

FIGURE 46.—Rice leaves affected with hoja blanca.

FIGURE 47.—Rice panicles affected with hoja blanca.

sidered by individual rice producers. Arkrose, Colusa, and Gulfrose are resistant to hoja blanca.

Kernel Smut

Kernel smut of rice is caused by one of the smut fungi, *Neovossia barclayana* Bref. (*31*). Part or all of the endosperm is replaced by a black mass of smut spores (fig. 48). One to several grains per panicle are affected. Other plant parts are not affected. The disease is easily overlooked in the field. It can be seen when rains wash the black spores over portions of the panicle or when the smut spore mass expands between the two hulls with absorption of moisture from dew or rain.

The black smut spores germinate and produce sporidia. When the rice flowers open at pollination, the sporidia enter. The fungus then invades the developing grain, grows, and produces its spores. Infection is not systemic in the rice plant, as it is with several other cereal smut fungi (*24*). Although the smut spores are seedborne (that is, they are carried into a field along with the seed), they are not directly responsible for later smut infection. Kernel smut is more prevalent in rainy seasons and in fields receiving fairly high rates of nitrogen fertilizer (*25*). Nitrogen applied late in the season also increases the incidence of kernel smut.

No satisfactory controls for kernel smut are known at present. Seed treatment by chemicals or hot water is ineffective. All long-grain varieties are susceptible. Most of the medium-grain varieties, except Nato, generally show less kernel smut.

FIGURE 48.—Rice panicle with several florets affected by kernel smut.

Kernel Spots

Discolored or dark areas and spots occur on the kernels of brown and milled rice. This kernel discoloration is generally associated with dark, discolored hulls. *Curvularia lunata* (Wakk.) Boed., *Fusarium* spp., *Alternaria* spp., *Trichoconis caudata* (Appel & Strunk) Clemments, and *Helminthosporium oryzae* are the fungi most commonly isolated (*29*). Feeding punctures of the immature grains by stink bugs also cause kernel spots (*17*).

At the time of some of the earlier studies (*21*, *26*, *29*), rice was binder harvested and placed in shocks. The change in harvesting methods from the binder to the combine has probably reduced losses from kernel spots.

Leaf Smut

Leaf smut, caused by *Entyloma oryzae* H. & P. Syd., is a common but minor rice disease in the southern rice area (fig. 49). The disease may be recognized by numerous, small, black sori on the leaves. The disease becomes more prevalent as the rice plants approach maturity.

FIGURE 49.—Leaf smut on rice leaves.

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INSECTS AND THEIR CONTROL

By Travis Everett

Rice Water Weevil

The rice water weevil (*Lissorhoptrus oryzophilus* Kuschel) occurs in most of the rice-growing areas of the United States. The adult weevil (fig. 50) is grayish brown and about one-eighth inch long. It overwinters in finely matted grasses growing in the vicinity of ricefields. In the spring it migrates into the ricefields and feeds on newly emerged plants, making slitlike, longitudinal feeding scars on the upper surface of the leaves. Eggs are laid in the leaf sheaths of rice plants. Larvae feed on the roots of rice plants and cause severe injury by pruning the root system. The young larvae, or root maggots as they are commonly called, are milky white, legless, and about one-half inch long when fully grown.

Since the immature stages of the rice water weevil are spent entirely under water among the rice roots, many of the larvae may be destroyed by drainage (*6*).[1] However, this practice is not recommended for controlling the root maggots because it is unreliable and also impractical in areas where water supplies are not abundant. The rice water weevil can be effectively controlled with insecticides.

[1] Italic numbers in parentheses refer to Selected References, p. 124.

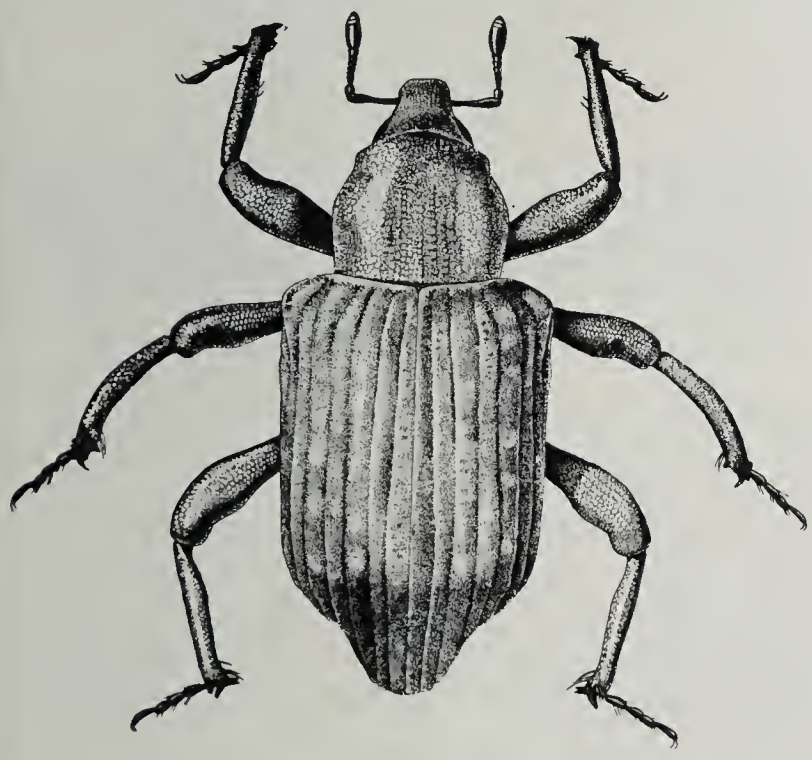

Figure 50.—Adult rice water weevil.

Rice Stink Bug

Practically all ricefields in Arkansas, Louisiana, and Texas are infested with the rice stink bug (*Oebalus pugnax* (Fabricius)). The adult stink bug (fig. 51) is a straw-colored, shield-shaped insect about one-half inch long. It passes the winter as an adult in the refuse near the surface of the ground in clumps of grass. It emerges from winter quarters in the spring and feeds on grasses and sedges. Two or three generations may be produced there before it migrates to rice soon after the rice begins to head. The eggs, shaped like short cylinders, are deposited on the leaves, stems, or heads of the rice, on grass, on Mexican-weed, and on other weeds. The eggs are usually laid in clusters of 10 to 40 in 2 rows,

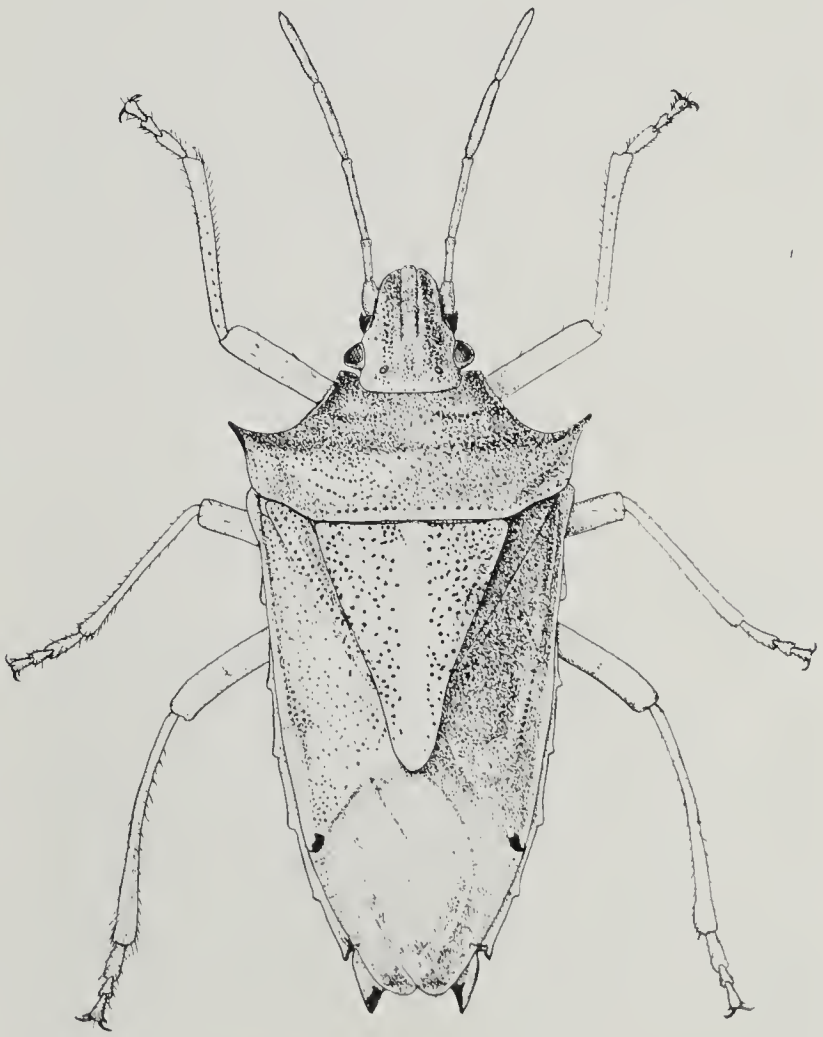

Figure 51.—Adult rice stink bug.

are green when first laid, and change to reddish black before hatching. The freshly hatched nymph is nearly round, about 1½ millimeters long and 1 millimeter wide. The head, thorax, legs, and antennae are black; the abdomen is red with two elongate black spots running crosswise. The young stink bugs remain together near the eggshells until after the first molt. Then they seek separate feeding places, generally on grass or on rice panicles, where they suck the juice from the developing kernels. Feeding in the milk stage of rice produces empty glumes, whereas feeding in the soft-dough stage causes "peckiness" of grain or seed sterility (*4*).

Since infestations build up on grasses earlier in the season, control of grasses in the field and mowing the areas around the field help reduce the potential population for infesting rice. Two hymenopterous egg parasites, *Ooencyrtus anasae* (Ashm.) and *Telenomus podisi* Ashm., are at times very helpful in reducing stink bug populations late in the season.

Grape Colaspis

The grape colaspis (*Maecolaspis flavida* (Say)), called lespedeza worm by ricegrowers, sometimes reduces plant stands severely in Arkansas and Louisiana (*9*). It passes the winter in the young larval stage. In the spring the larvae make their way toward the soil surface where they feed on germinating seeds or seedlings. Heavy infestations may reduce stands so severely that reseeding is necessary. The larvae pupate in the soil and emerge as pale brown, elliptical beetles about one-eighth inch long. Adults of the grape colaspis lay their eggs in the soil around the roots of grasses growing in lespedeza or other leguminous crops. Rice planted following these crops is subject to damage.

Other Pests of Rice

Several other pests occasionally cause serious damage to rice.

The rice leaf miner (*Hydrellia griseola* var. *scapulasis* Loew) is a pest of rice in California (*7*). Maggots of this fly feed in the leaves of young rice plants and destroy the leaf tissue. Infested leaves turn brown and lie prostrate on the water. This pest is seldom present in sufficient numbers to warrant control measures.

Grasshoppers are found in nearly all ricefields, but seldom are present in sufficient numbers to cause severe damage (*2*). They feed on the leaves, culms, and grain of rice.

Sporadic outbreaks of the fall armyworm (*Spodoptera frugiperda* (J. E. Smith)) (fig. 52) have been recorded at irregular intervals and in

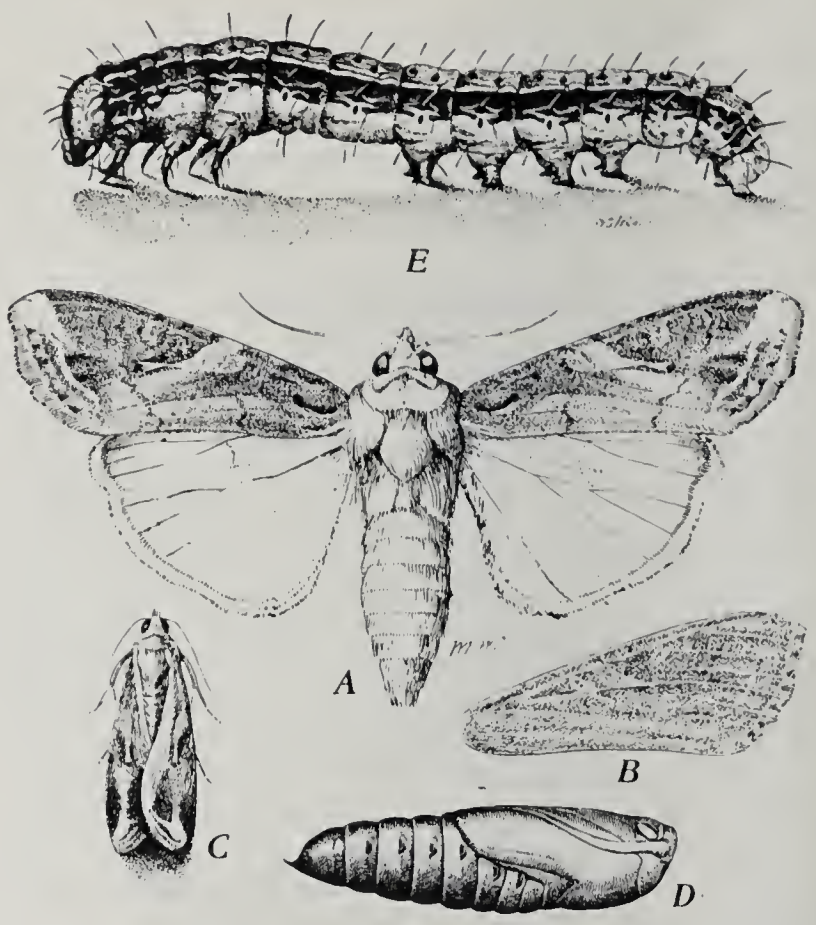

FIGURE 52.—Fall armyworm: *A*, Male moth; *B*, right front wing of female moth; *C*, moth in resting position; *D*, pupa; *E*, full-grown larva. *A*, *B*, *D*, *E* about × 2; *C* slightly enlarged.

widely separated localities. It feeds on leaves and stems of unflooded rice. Submerging the rice crop is usually effective in controlling this insect.

The rice stalk borer (*Chilo plejadellus* Zincken) (fig. 53) and the sugarcane borer (*Diatraea saccharalis* (Fabricius)) (fig. 54) both occur in rice-

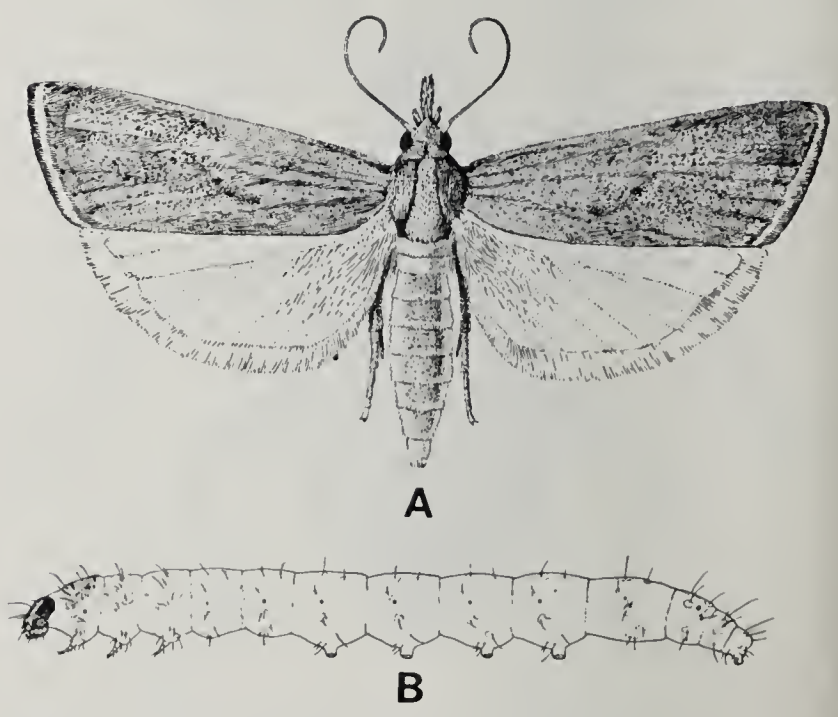

FIGURE 53.—Rice stalk borer: *A*, Adult; *B*, larva. About × 3.

FIGURE 54.—Adult female sugarcane borer.

fields in Louisiana and Texas (*3*). These borers tunnel inside the stem throughout the growing season and interfere with normal growth and development of the plant. They may also weaken the stem so that it breaks off or lodges before harvest. Stalk borer damage is first noticeable on the rice plant at time of heading when sterile heads with white panicles, or white heads as they are commonly called, appear. The eggs of both species of borers are parasitized by the minute wasp (*Trichogramma minutum* Riley), which helps reduce insect populations. Plowing under rice stubble in the spring destroys some of the overwintering borers. Grazing with cattle or flooding rice stubble fields reduces the number of hibernating borers. Ricefields should be separated as far as possible from corn and sugarcane because these two crops serve as a breeding place for the sugarcane borer.

The planthopper (*Sogata orizicola* Muir) is potentially a very important pest of rice. It is the only known vector of hoja blanca, the rice disease that has become the scourge of rice production in several Latin American countries. *S. orizicola* was first reported in the United States in 1957. Although the planthopper was found in Mississippi in 1958 and in Louisiana in 1959 (*1*) and in 1962, neither it nor the disease it transmits has become established in the United States. Apparently the vector cannot survive the cold weather that sometimes occurs in the rice-growing areas of this country.

The chinch bug (*Blissus leucopterus* (Say)) (fig. 55) is present in Arkansas, Louisiana, and Texas (*3*). It has entered ricefields in large numbers and seriously injured the young rice plants before they were submerged. Both adults and nymphs attack rice. The feeding of bugs causes the plants to wither and die. Chinch bugs feed mainly on the stems, just above the surface of the ground. They may be controlled by submerging the infested field. The insects spend the winter in dry grass, straw, and other material that affords them shelter. Plowing under such material in the fall or winter reduces

FIGURE 55.—Chinch bugs. Enlarged.

the number of bugs emerging the following spring.

The tadpole shrimp (*Triops longicaudatus* (LeConte)), although not an insect, is sometimes a pest in California (*10*). Damage occurs shortly after fields are flooded and when eggs laid in fields the previous year hatch. Shrimp larvae at first feed on organic matter in the soil; but as they mature, they dislodge and feed on young rice plants. The shrimp matures in 8 to 10 days and may produce a second generation.

For information on the insecticides currently recommended for control of rice insects, consult your county agent, State agricultural experiment station, or the U.S. Department of Agriculture, Washington, D. C. 20250.

PRECAUTIONS

Insecticides are poisonous. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the container label. Insecticides should be kept in closed, well-labeled containers, in a dry place where they will not contaminate food or feed and where children and pets cannot reach them. Avoid repeated or prolonged contact with skin and inhalation of dusts and mists. Methyl parathion and phosphamidon should be applied only by persons experienced in handling and applying poisonous chemicals. Operators exposed to sprays containing methyl parathion and phosphamidon should wear half masks equipped with cartridges of a type approved by the U.S. Department of Agriculture. Wear clean, dry clothing, and wash hands and face before eating or smoking. When handling concentrates, avoid spilling them on the skin and keep them out of the eyes, nose, and mouth. If any is spilled, wash it off the skin and change clothing immediately. If it gets in the eyes, flush with plenty

of water for 15 minutes and get medical attention.

Avoid drift of insecticide sprays or dusts to nearby crops, livestock, or bee yards. Sprays or dusts applied by airplane and other power equipment are especially likely to drift. Do not allow poultry, dairy animals, or meat animals to feed on plants or drink water contaminated by drift of insecticides. Do not clean spraying equipment or dump excess spray material near streams, lakes, or ponds.

Do not apply—

Aldrin or malathion within 7 days before harvest.

Carbaryl (Sevin) [2] within 14 days before harvest.

Methyl parathion within 15 days before harvest.

Phosphamidon within 21 days before harvest.

Dieldrin within 30 days before harvest.

Do not apply DDT to rice after heads start to form.

Do not feed rice straw to dairy animals or animals being finished for slaughter if the rice straw has been treated with DDT, phosphamidon, or toxaphene.

Do not feed rice straw to livestock if the rice straw was treated with aldrin within 30 days of harvest or with dieldrin within 20 days of harvest.

[2] Sevin should not be applied to rice that has been or will be treated with DPA herbicide.

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